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Front Pages

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Editorial and Reviewers' Board

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The current issue is the first of the thirteenth volume of the *Athens Journal of Tourism (AJT)*, published by the Tourism, Leisure & Recreation Unit of Athens Institute.

Gregory T. Papanikos
President
Athens Institute

Athens Institute for Education and Research

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- Submission of Paper: **22 February 2027**

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Tourism-driven Water Metabolism in Coastal Destinations: Governance Tensions and Sustainability Implications from Puerto Vallarta, Mexico

By José Luis Cornejo-Ortega[*]

Tourism growth in coastal destinations has intensified pressure on local water systems, generating complex tensions between economic development, territorial equity and environmental sustainability. Despite increasing academic attention to tourism–water interactions, integrated socio-ecological analyses remain limited, particularly in tourism-dependent regions of Latin America. This article critically examines the relationship between tourism development and water governance through a qualitative case study of Puerto Vallarta, Mexico. The research adopts a systematic documentary analysis combining scientific literature and institutional sources to identify structural patterns linking tourism expansion, water demand dynamics, governance arrangements and socio-environmental impacts. The findings suggest that tourism functions as a key driver of the socio-hydrological metabolism of coastal destinations, reinforcing territorial redistribution of water resources, increasing dependence on groundwater extraction and externalizing environmental and financial costs to public institutions and local ecosystems. Although recent policy responses emphasize circular water strategies focused on efficiency improvements and wastewater reuse, their implementation remains largely incremental and insufficient to offset rising total consumption levels associated with tourism growth. As a result, adaptation strategies tend to reinforce functional forms of territorial resilience oriented toward maintaining tourism competitiveness rather than addressing structural socio-ecological vulnerabilities. By integrating the analytical perspectives of political ecology of water, circular economy and territorial resilience, this study proposes a socio-hydrological framework for understanding tourism-related water governance in coastal destinations. The article contributes to tourism sustainability debates by highlighting the need for systemic policy approaches that incorporate ecological limits, promote equitable resource allocation and address the structural drivers of tourism-induced water demand.

Keywords: *Water governance; Tourism water use; Socio-hydrology; Circular economy; Territorial resilience*.

Introducción

Water constitutes a strategic resource for the functioning of coastal tourism destinations, both in terms of meeting the basic needs of resident populations and sustaining the operational requirements of contemporary tourism infrastructure. Hotels, restaurants, recreational complexes and urban services associated with tourism depend on a continuous and high-quality water supply, positioning the sector as

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one of the most intensive users of water resources in many coastal territories (Gössling et al. 2012, Becken 2014).

Over recent decades, the accelerated expansion of international tourism and the consolidation of large-scale urban–tourism development models have significantly increased pressure on local water systems, particularly in regions characterized by limited availability, strong seasonality of demand and growing climate vulnerability. In such contexts, water management has evolved from a primarily technical challenge to a complex socio-environmental issue shaped by tensions between economic growth, territorial equity and ecological limits. Recent studies highlight how the interaction between tourism development, climate change and water availability intensify structural vulnerabilities in highly tourism-dependent coastal regions (Hall et al. 2020, Gössling 2021).

Tourism-related water consumption often exceeds domestic levels, generating persistent asymmetries in access and functional redistribution of water resources toward economically prioritized areas (Cole 2012, Gössling et al. 2015). At the same time, the environmental and financial costs associated with infrastructure expansion, groundwater extraction and wastewater treatment are frequently externalized to local governments and communities, while economic benefits remain concentrated among private tourism actors (Becken 2014, Navas & Cuvi 2015). From a political ecology perspective, these dynamics reflect institutional arrangements and power relations that shape unequal patterns of water allocation and governance.

In response to these challenges, sustainability-oriented approaches have gained relevance, particularly the circular economy of water, focused on efficiency, reuse and resource loop closure, and the concept of territorial resilience, understood as the capacity of socio-ecological systems to adapt and transform in the face of environmental and climatic disturbances (Geissdoerfer et al. 2017, UN-Water 2013). However, critical scholarship argues that such strategies are often implemented in a technocratic and incremental manner, prioritizing operational optimization without addressing absolute levels of consumption or the structural drivers of tourism growth (Cole 2014, Cruz et al. 2019).

Despite the growing international literature on tourism and water sustainability, integrated empirical analyses remain limited in Latin American coastal destinations, where institutional constraints, strong tourism dependency and socio-environmental pressures frequently converge. In Mexico, major coastal tourism poles are experiencing accelerated urbanization and increasing water demand, yet studies adopting critical and multi-scalar perspectives remain scarce.

Puerto Vallarta, one of the most consolidated tourism destinations on Mexico's Pacific coast, represents a paradigmatic case of these tensions. Sustained hotel expansion, real estate development and a marked dependence on groundwater sources have intensified pressure on the local water system, revealing conflicts between tourism service provision, urban needs and long-term environmental sustainability.

Against this backdrop, this article aims to critically examine the relationship between tourism development and water management in coastal destinations through a systematic documentary analysis applied to the case of Puerto Vallarta, Jalisco. By integrating the analytical frameworks of political ecology of water, circular economy and territorial resilience, the study seeks to assess the scope and

limitations of circular water strategies and their potential contribution to socio-ecological sustainability.

The article contributes in three main ways. First, it articulates theoretical perspectives that are rarely analyzed jointly within tourism studies. Second, it suggests the analytical value of critical documentary analysis for understanding complex socio-ecological processes at the territorial scale. Third, it provides empirical evidence from a Latin American destination, contributing to the geographical diversification of research on tourism and water governance. The paper is structured into four sections: theoretical framework, methodology, results organized around six analytical axes, and discussion of implications for sustainable water governance in coastal tourism destinations.

Theoretical Framework

The relationship between tourism development and water use has gained increasing attention in sustainability research, particularly in coastal destinations where resource availability is limited and tourism demand is highly seasonal. The expansion of tourism infrastructure — including hotels, recreational facilities and urban services — intensifies water consumption and reshapes territorial patterns of access, generating tensions between economic growth, social equity and environmental conservation (Gössling et al. 2012, Becken 2014).

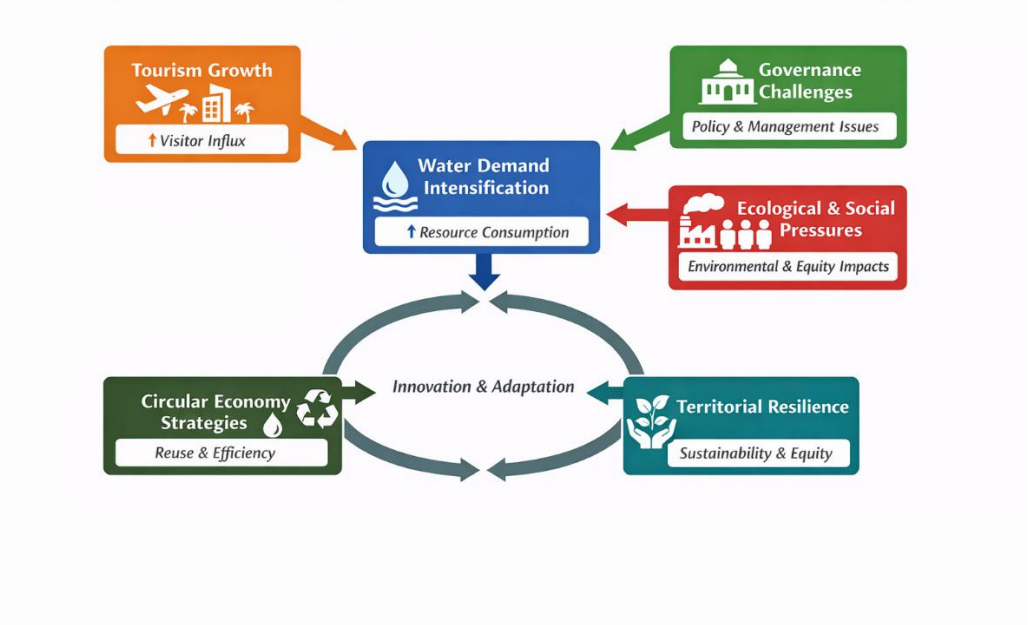
Empirical evidence shows that tourism-related water consumption frequently exceeds domestic use, especially in medium and high category accommodation establishments where services such as swimming pools, laundry operations, landscaping and golf courses significantly increase demand (Rico-Amorós et al. 2009). In many destinations, these dynamics contribute to spatial prioritization of water supply toward economically strategic tourism areas, reinforcing unequal access to resources and increasing pressure on groundwater systems.

From this perspective, water management in tourism destinations cannot be understood solely as a technical challenge of supply provision but must be analyzed as a socio-political process shaped by institutional arrangements and power relations. The political ecology of water provides a relevant analytical framework by conceptualizing water as a common resource whose distribution is mediated by governance structures, territorial conflicts and competing development priorities (Cole 2012, 2014). This approach highlights how allocation decisions often favor economically dominant sectors such as tourism, consolidating patterns of functional redistribution and environmental inequality.

In parallel, the concept of circular economy has emerged as a key sustainability paradigm aimed at reducing resource extraction and minimizing waste through efficiency improvements, reuse and the closure of material cycles (Geissdoerfer et al. 2017). In tourism contexts, circular water strategies, including wastewater treatment, leakage reduction and technological optimization, have been promoted as mechanisms to enhance environmental performance and reduce operational costs (Figure, 1). However, when circularity is limited to incremental efficiency gains without addressing absolute consumption levels or structural drivers of tourism expansion, its

transformative potential remains constrained (Cruz et al. 2019, Styles et al. 2015). This distinction between weak and strong circularity is crucial, as efficiency improvements may be offset by continued growth in tourism demand, reproducing overall water stress (Kirchherr et al. 2017).

Figure 1. *Circular Water Management Model in Tourism Destinations*



Source: Authors' own elaboration.

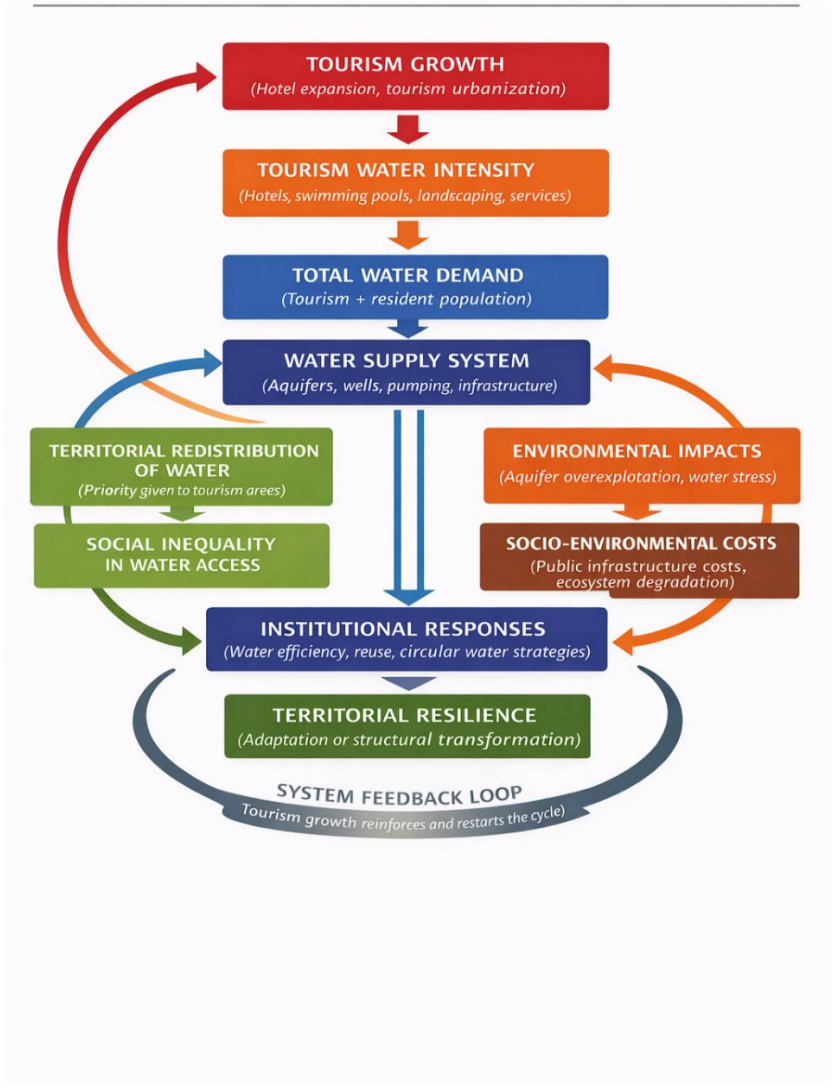
Complementing these perspectives, territorial resilience offers a systemic lens to assess the capacity of tourism destinations to adapt to environmental, climatic and socio-economic disturbances. Beyond ensuring technical reliability of supply systems, resilience involves the ability to transform development pathways and reduce long-term vulnerabilities (Scott et al. 2012, UN-Water 2013). In highly tourism-dependent coastal regions, such transitions are particularly challenging due to economic specialization and institutional inertia associated with maintaining tourism competitiveness.

Rather than operating as independent analytical lenses, political ecology of water, circular economy and territorial resilience are understood in this study as mutually constitutive dimensions of a single socio-hydrological system shaped by tourism development. Political ecology provides insight into the power relations and institutional arrangements that determine how water is allocated across territories and social groups, particularly under conditions of tourism-driven demand (Cole 2012, 2014, Navas & Cuvi 2015). Circular economy approaches, in turn, define the operational logic through which water flows are managed, optimized and potentially reconfigured within the tourism system, revealing both the possibilities and limits of efficiency-based interventions (Geissdoerfer et al. 2017, Kirchherr et al. 2017, Styles et al. 2015). Territorial resilience integrates these dynamics temporally and spatially, capturing how governance structures and resource management strategies either reinforce or transform existing development

trajectories (Scott et al. 2012, UN-Water 2013). From this perspective, tourism-driven water metabolism emerges from the interaction between distributive conflicts (political ecology), resource flow management (circular economy) and adaptive capacity (resilience), generating feedback loops between social and hydrological systems that may stabilize or intensify socio-ecological pressures (Di Baldassarre et al. 2019, Gössling et al. 2012). This relational articulation allows for a more comprehensive understanding of water governance in coastal tourism destinations, moving beyond fragmented interpretations toward a systemic and process-oriented analytical framework.

This integrated socio-hydrological framework guides the empirical analysis by enabling the identification of structural interactions between tourism development, water demand dynamics, institutional responses and territorial sustainability outcomes (Figure 2).

Figure 2. *Integrated Socio-hydrological Framework of Tourism and Water Governance in Coastal Destinations*



Source: Authors' own elaboration.

Methodology

This research adopts a qualitative approach grounded in a critical-interpretive paradigm within the social sciences. From this perspective, water management is understood not merely as a technical issue of supply efficiency but as a socio-ecological process shaped by institutional arrangements, power relations and territorial conflicts related to resource allocation.

An instrumental case study design was employed, focusing on Puerto Vallarta, Jalisco, Mexico. The case was selected due to its consolidation as a highly specialized coastal tourism destination, its strong economic dependence on tourism and the increasing pressure exerted on local water supply systems. These characteristics make it representative of broader dynamics observed in tourism-dependent coastal regions of Latin America.

The research strategy is based on systematic critical documentary analysis. This methodological approach enables the integration of theoretical insights from scientific literature with empirical evidence derived from institutional sources, allowing for a multi-scalar interpretation of tourism–water interactions.

Two complementary documentary corpora were constructed. The first corpus consists of peer-reviewed academic publications addressing tourism water consumption, environmental governance, circular economy and territorial resilience. These sources provided the analytical categories guiding the study (Table 1).

Table 1. *Scientific Literature Corpus used for Analytical Framework Construction*

Author(s)	Year	Document type	Main focus	Contribution to the study
Gössling et al.	2012	Journal article	Tourism and water use	International comparative basis on tourism water intensity
Becken	2014	Journal article	Water equity in tourism	Tourism–local community water uses relationships
Cole	2012	Journal article	Political ecology of water	Unequal distribution of water resources
Cole	2014	Journal article	Water governance	Political dimension of water supply management
Rico-Amorós et al.	2009	Journal article	Tourism land use and water demand	Water intensity in Mediterranean destinations
Scott et al.	2012	Academic book	Climate change and tourism	Structural vulnerability of tourism systems
Gössling et al.	2015	Academic book	Tourism and water	Conceptualization of tourism water metabolism
Geissdoerfer et al.	2017	Journal article	Circular economy	Circularity as a sustainability paradigm

Kirchherr et al.	2017	Journal article	Strong vs weak circularity	Transformational limits of circular economy approaches
Styles et al.	2015	Journal article	Environmental performance in hotels	Resource efficiency in tourism accommodation
Di Baldassarre et al.	2019	Journal article	Socio-hydrology	Interaction between social and hydrological systems
UN-Water	2013	Institutional report	Water security	International governance framework
Vera	2006	Journal article	Coastal water management	Territorial conflicts over water resources
Milano et al.	2021	Journal article	Overtourism	Limits of tourism growth
Hall et al.	2020	Journal article	Sustainable transformations	Structural change in tourism systems
Cruz et al.	2019	Book chapter	Circular tourism	Critique of incremental efficiency approaches
Navas & Cuvi	2015	Journal article	Water conflicts in Latin America	Political ecology perspective in the region
Hernández et al.	2020	Journal article	Tourism and water accumulation	Socio-environmental externalization dynamics

The second corpus includes institutional and technical documents related to water production, infrastructure capacity, seasonal demand patterns and urban planning instruments in Puerto Vallarta. These documents allowed for the empirical characterization of local water supply structures and demand dynamics (Table 2).

Table 2. *Institutional and Technical Documents used in the Empirical Analysis*

Document type	**Issuing institution**	**Main content**	**Contribution to the analysis**
Annual report on water production and consumption	Municipal water utility	Extraction volumes and territorial distribution	Evidence of groundwater dependence
Hydraulic infrastructure report	Drinking water utility system	Number of wells and installed capacity	Supply expansion dynamics
Seasonal demand statistics	Water utility operator	Monthly consumption variations	Tourism-related water intensity
Municipal Development Plan	Municipal government	Urban growth priorities	Tourism–planning relationship
Territorial land-use planning program	State/municipal government	Zoning and urban expansion patterns	Territorial redistribution of

			water resources
Water quality certification reports	Public health authority	Water quality standards and service continuity	Operational supply priorities
Financial reports of the water system	Water utility operator	Public investment in infrastructure	Externalization of socio-environmental costs
Local academic technical studies	Universities and research centers	Technical diagnoses of water management	Analytical complement and contextual validation
Institutional communications during peak seasons	Water utility operator	Operational adjustments under high demand	Territorial prioritization strategies

The analytical process involved comparative and interpretive reading of both corpus in order to identify recurring patterns, tensions between policy discourse and operational practices, mechanisms of socio-environmental cost externalization and structural interactions between tourism growth and ecological limits.

The analytical process involved a theoretically informed interpretive approach based on iterative interaction between conceptual frameworks and empirical evidence. Rather than emerging purely inductively, the six analytical axes were identified through a process of analytical refinement in which patterns observed in the documentary corpus were interpreted in light of the theoretical perspectives of political ecology of water, circular economy and territorial resilience. This approach allowed for both the recognition of empirically grounded regularities and their conceptual articulation within a broader socio-hydrological framework. To enhance analytical rigor, the study incorporated source triangulation, cross-scalar comparison and documentary traceability, while also considering convergent and, where present, divergent evidence across the analyzed sources. Given its qualitative nature, the research does not aim to establish statistical causality but to provide a structurally informed interpretation of tourism–water interactions in coastal destinations.

This approach aligns with qualitative research traditions that emphasize the co-construction of analytical categories through continuous dialogue between theory and empirical material.

Results

To empirically contextualize the relationship between tourism development and water management in Puerto Vallarta, key structural indicators of the local water system and tourism activity are presented in Table 3. These indicators illustrate the magnitude of seasonal demand pressures, the strong dependence on groundwater sources and the significant role of tourism as a driver of water consumption dynamics in the destination.

Table 3. *Water System Indicators and Tourism Pressure in Puerto Vallarta*

Indicator	Approximate value	Institutional source	Analytical interpretation
Resident population (municipality)	~291,000 inhabitants	INEGI (2020)	Demographic baseline of urban water demand
Annual tourist arrivals	~6.4 million	Jalisco Ministry of Tourism (2023)	High tourism intensity relative to resident population
Registered hotel rooms	~25,000	Jalisco Ministry of Tourism (2023)	Large installed capacity of the tourism system
Average daily drinking water production	~1,300–1,400 liters per second	SEAPAL Vallarta (2022)	Operational capacity of the supply system
Groundwater sources share	>80% of total supply	CONAGUA (2020)	Strong dependence on local aquifers
Approximate number of supply wells	~30 wells	SEAPAL Vallarta (2021)	Core groundwater extraction infrastructure
Average domestic water consumption	180–220 liters per capita/day	CONAGUA (2022)	Standard urban consumption level
Estimated hotel water consumption	300–800 liters per tourist/day	Gössling et al. (2012); Rico-Amorós et al. (2009)	Significantly higher tourism water intensity
Seasonal increase in water demand	10–20%	SEAPAL Vallarta (2022)	Tourism-driven peak demand pressure
Economic dependence on tourism	>70% of local economic activity	Jalisco Ministry of Tourism	Structural prioritization of water supply

The documentary analysis also allowed the identification of six analytical axes that synthesize the main structural dimensions through which tourism development reshapes water use, governance arrangements and socio-environmental pressures in the destination. Table 4 summarizes these axes and their implications for water sustainability.

Table 4. *Analytical Synthesis of Tourism–Water Interactions in Puerto Vallarta*

Analytical axis	**Documentary evidence**	**Structural interpretation**	**Implications for water sustainability**
Territorial appropriation and redistribution of water	Priority supply continuity in hotel zones during peak demand periods; dependence on groundwater sources	Tourism appears to operate as a spatial driver of selective water allocation and functional redistribution of the resource	Reinforces territorial inequalities and increases vulnerability of peripheral residential areas
Water intensity of the tourism model	Seasonal peaks in water production and higher per capita consumption in hotels compared to residential use	The evidence suggests that tourism may function as a structural multiplier of water demand linked to high-comfort service provision	Efficiency measures alone are insufficient to offset increasing total water consumption
Externalization of socio-environmental costs	Public investment in wells, pumping systems and wastewater infrastructure to sustain tourism growth	Environmental and financial costs are transferred to public institutions and local ecosystems	Distorts real economic valuation of tourism and delays recognition of ecological limits
Institutional water governance	Centralized decision-making and operational prioritization of supply continuity in tourism corridors	Technocratic governance frames water scarcity as a supply problem rather than a demand regulation issue	Limits participatory planning and weakens regulatory capacity over intensive tourism consumption
Circular water strategies	Implementation of efficiency improvements, leakage reduction and limited wastewater reuse	The evidence suggests that circularity operates mainly as incremental optimization without reducing absolute water demand	Weak circular transition risks legitimizing continued tourism expansion
Territorial water resilience	Expansion of supply infrastructure as the main adaptation strategy to seasonal demand increases	Resilience is predominantly functional and oriented toward maintaining tourism growth dynamics	Long-term socio-ecological vulnerability remains structurally unresolved

Territorial Appropriation and Redistribution of Water

Documentary evidence indicates that water supply continuity is strategically prioritized in tourism corridors and high-density hotel zones, particularly during peak demand periods. This operational prioritization contributes to functional redistribution of water resources within the urban territory, often resulting in intermittent supply conditions in peripheral residential areas. Such patterns reflect the spatial influence of tourism development on water allocation decisions and reinforce territorial inequalities in access to basic services.

Water Intensity of the Tourism Model

Tourism appears to operate as a structural multiplier of water demand due to the service requirements associated with accommodation, recreational infrastructure and landscape maintenance. Institutional data reveal seasonal increases in water production linked to peak tourist arrivals, while the literature consistently documents higher per capita consumption levels in tourism establishments compared to residential use. These dynamics intensify pressure on local aquifers and increase the operational complexity of supply systems.

Externalization of Socio-environmental Costs

The expansion of tourism infrastructure has required sustained public investment in wells, pumping systems, distribution networks and wastewater treatment facilities. Documentary sources show that environmental and financial costs associated with maintaining supply capacity are largely absorbed by public institutions and local ecosystems, while tourism-related economic benefits remain concentrated among private actors. This externalization of costs delays recognition of ecological limits and may distort the long-term sustainability of tourism development.

Institutional Water Governance

Water management in the destination is characterized by centralized decision-making structures focused on ensuring supply reliability in economically strategic areas. Planning instruments and operational practices tend to frame water scarcity as a technical supply challenge rather than a demand regulation issue. This governance configuration limits participatory mechanisms and reduces the capacity to implement structural measures aimed at moderating intensive tourism consumption patterns.

Circular Water Strategies

Recent institutional initiatives emphasize efficiency improvements, leakage reduction and the gradual incorporation of wastewater reuse practices. While these strategies contribute to operational optimization, documentary evidence suggests that their implementation remains incremental and insufficient to offset growing

total water demand driven by tourism expansion. Consequently, circular approaches risk legitimizing continued growth without fundamentally transforming consumption patterns.

Territorial Water Resilience

Adaptation strategies in Puerto Vallarta are predominantly oriented toward expanding supply infrastructure in response to seasonal demand increases. Although such measures enhance short-term system reliability, they reinforce a functional form of resilience aimed at maintaining tourism growth dynamics rather than addressing structural socio-ecological vulnerabilities. This pathway may increase long-term exposure to water stress under conditions of climatic variability and continued urban–tourism expansion.

Discussion

The findings of this study should be interpreted as theoretically informed insights into the socio-hydrological dynamics of tourism-dependent coastal destinations rather than as direct empirical verification of causal relationships. The patterns identified in Puerto Vallarta suggest that tourism development is associated with intensified water demand, territorial redistribution of supply and the externalization of socio-environmental costs, in ways that are consistent with existing theoretical perspectives in political ecology and socio-hydrology (Gössling et al. 2012, Cole 2014). Similarly, the observed limitations of circular water strategies can be interpreted as indicative of a predominance of incremental efficiency-oriented approaches, which may be insufficient to offset increasing total consumption levels associated with tourism growth, as discussed in the literature on weak circularity (Geissdoerfer et al. 2017, Kirchherr et al. 2017). From this perspective, the apparent reinforcement of growth-oriented trajectories may be understood as a form of functional territorial resilience that stabilizes existing development patterns rather than transforming underlying structural conditions. These interpretations are consistent with broader debates on socio-hydrological feedbacks and path dependency in resource-intensive systems (Di Baldassarre et al. 2019).

The results suggest that tourism development in Puerto Vallarta significantly reshapes local water dynamics through processes of intensified consumption, territorial redistribution of supply and externalization of socio-environmental costs. These patterns are consistent with international evidence showing that tourism operates as a structural driver of resource metabolism in coastal destinations, particularly where economic specialization reinforces dependence on high-consumption service models (Gössling et al. 2012, Becken 2014).

From a political ecology perspective, the prioritization of water allocation in tourism corridors reflects governance arrangements that favor economically strategic activities, often at the expense of residential access and long-term ecological sustainability. Similar dynamics have been documented in Mediterranean destinations

such as the Balearic Islands and coastal Spain, where tourism growth has historically contributed to increased groundwater extraction and spatial inequalities in water distribution (Rico-Amorós et al. 2009, Cole 2014). These patterns suggest that water scarcity in tourism-dependent regions is not solely a function of physical availability but also of institutional decision-making and development priorities.

The results also indicate that circular water strategies in the destination remain largely oriented toward incremental efficiency improvements rather than structural demand regulation. While measures such as leakage reduction and wastewater reuse contribute to operational optimization, their capacity to offset rising total consumption driven by tourism expansion is limited. This finding aligns with broader debates in sustainability research highlighting the risk of "weak circularity," whereby technological solutions improve resource efficiency without reducing absolute pressures on ecosystems (Geissdoerfer et al. 2017, Kirchherr et al. 2017).

In this context, territorial resilience emerges as a contested and unevenly distributed process. Adaptation strategies based on expanding supply infrastructure enhance short-term system reliability but may reinforce long-term vulnerability by sustaining growth-oriented tourism models. From a socio-hydrological perspective, feedback loops between tourism demand, infrastructure development and ecological stress can lock destinations into trajectories of increasing resource dependency (Di Baldassarre et al. 2019).

While some institutional documents report improvements in efficiency and service continuity, these advances do not necessarily translate into reductions in overall water demand, particularly under conditions of sustained tourism growth.

Overall, the integrated framework applied in this study suggests the analytical value of combining political ecology of water, circular economy and territorial resilience perspectives to understand tourism-related water governance as a complex socio-ecological process. This articulation allows for moving beyond purely technical interpretations of water management and highlights the need for policy approaches that address structural drivers of demand, promote equitable allocation mechanisms and incorporate ecological limits into tourism planning.

Conclusions

This study examined the relationship between tourism development and water management in a coastal destination characterized by strong economic dependence on tourism and increasing pressure on local water resources. Through systematic documentary analysis applied to the case of Puerto Vallarta, the research identified structural interactions between tourism growth, intensified water demand, territorial redistribution of supply and the externalization of socio-environmental costs.

The findings suggest that tourism functions as a key driver of the socio-hydrological metabolism of coastal destinations, reinforcing patterns of unequal access to water and increasing reliance on groundwater extraction. Although institutional responses have increasingly incorporated circular water strategies focused on efficiency and reuse, their implementation remains predominantly

incremental and insufficient to offset rising total consumption levels associated with tourism expansion.

From a governance perspective, water management continues to be framed primarily as a technical challenge of infrastructure provision rather than as a structural issue linked to demand regulation and development planning. This orientation limits the transformative potential of sustainability initiatives and contributes to the persistence of functional forms of territorial resilience aimed at maintaining tourism competitiveness rather than addressing long-term socio-ecological vulnerabilities.

By integrating the perspectives of political ecology of water, circular economy and territorial resilience, this article contributes to tourism studies by providing a comprehensive socio-ecological framework for understanding water governance in coastal destinations. The research also expands empirical evidence from Latin America, a region where tourism dependency, institutional constraints and environmental pressures frequently converge.

The results suggest the need to move beyond efficiency-oriented approaches toward more systemic policy interventions that incorporate ecological limits, promote equitable water allocation and encourage demand management strategies within tourism planning processes. Future research could further explore comparative socio-hydrological dynamics across coastal destinations, as well as the role of climate variability and urban growth in shaping long-term water sustainability trajectories.

Ultimately, achieving water sustainability in coastal tourism destinations requires moving beyond efficiency-based adaptation toward transformative governance capable of redefining the limits and trajectories of tourism development

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Characterization and Valorization of the Jurassic Geoheritage in the Eastern Middle Atlas: A Standardized Inventory Approach for Geosite Promotion

By Souhail Mounir[*] & Naoufal Saoud[±]

The Middle Atlas, a 500 km-long mountainous massif dominated by Jurassic carbonate formations, possesses remarkable yet vulnerable geodiversity. Despite this wealth, the absence of a systematic inventory and rigorous characterization of geological objects limits the potential for effective protection and valorization. The primary challenge of this study is to identify and qualify these entities to halt heritage degradation caused by uncoordinated territorial development and a lack of formal geoconservation strategies. The core interest of this research lies in the identification, classification, and documentation of geosites with high heritage value. The methodology is based on the approach developed in our doctoral research (2020), integrating Geographic Information Systems (GIS) and 3D modeling for precise spatial analysis. Each potential geosite underwent a multi-criteria diagnostic assessment—evaluating scientific value, educational potential, and vulnerability—to establish a robust database of detailed inventory sheets. The study successfully characterized a series of representative geosites, including karst systems, tectonic structures, and paleontological and archaeological sites. These geosites serve as the fundamental units of the regional geotourism offer and have been organized into thematic geological tours. The use of 3D modeling and descriptive sheets provides a deep understanding of the genesis and functioning of each site, ensuring a faithful representation of both tangible and intangible geoscientific heritage. The valorization of these geosites through scientific mediatization and geotourism acts as an immediate lever for socio-economic development. Ultimately, grouping these high-interest sites within a coherent perimeter justifies and supports the establishment of a UNESCO Global Geopark, ensuring sustainable management and international recognition of this exceptional heritage.

Keywords: *Geodiversity, Geo-heritage, Geotourism, Geosite, Geopark, Middle Atlas, Morocco*

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Introduction

The geographical environment integrating geology, geomorphology, climatology, and socio-economics, constitutes a distinct geotouristic product. The strategic valorization of this geological heritage, through scientific dissemination, is a key driver for developing new tourist flows and fostering regional growth (Williams 2008).

The Eastern Middle Atlas, situated south of the historic city of Taza, offers a vast array of natural and cultural potentialities (Zine El Abidine 2024). Its diverse landscapes form an undeniable natural heritage that grants the region a remarkable identity. The study area proposed for this Geopark project exhibits significant geodiversity, providing a foundation to define, identify, and classify remarkable geological objects, grouped as "Geosites."

The exceptional characteristics of the dolomitic and limestone formations, combined with specific tectonic, geomorphological, and hydrological features, have led to the development of extensive karst networks. These include complex underground cavities such as avens, caves, and underground rivers as well as highly developed surface networks like sinkholes, dolines, and poljes (Mounir, 2020). Among these, the Tazekka dome-shaped massif stands out as the most prominent geological structure in the eastern Middle Atlas. Its unique biodiversity and geological diversity, characterized by exceptional tectonic and geochemical features, hold immense scientific and educational value.

To effectively manage and promote this complex heritage, a rigorous inventory and characterization approach was implemented, as detailed in the following methodology.

The promotion of geoheritage as a driver for territorial development is experiencing significant momentum in Morocco, supported by a growing body of academic research. While foundational studies (El Hadi et al. 2011, Errami et al. 2015) established the initial basis for national geoconservation, more recent research has shifted focus toward the specific characterization of Atlasic massifs. In the Middle Atlas, the work of Mounir 2020, Baadi et al. 2021, El Hamdi et al. 2024 and the hydro-karst analyses (Mounir et al. 2019) emphasize the complexity and exceptional value of the geological archives within the Taza region.

The concept of "Geoheritage", at the heart of this study, defines geological objects possessing remarkable scientific, educational, or aesthetic value (Brilha 2016, Mounir et al. 2021). It is no longer merely about preserving isolated sites but about integrating these "Earth archives" into a vision of sustainable development. In Morocco, this ambition is bolstered by the success of the M'Goun UNESCO Global Geopark, which serves as a model for the emergence of new geotourism hubs. Our approach aligns with this trend, utilizing modern digital tools to transform scientific knowledge into a socio-economic asset for the local populations of the Middle Atlas.

By prioritizing the identification of geosites as fundamental units, this research contributes to the national effort of documenting Morocco's "memory of the Earth." It aims to bridge the gap between pure geoscientific research and practical territorial management, ensuring that geological diversity becomes a pillar of regional identity and economic resilience.

Location and Geological Setting

The study area is located in the northern part of the Middle Atlas. It belongs to the major watersheds of Sebou and Moulouya. The region includes two national parks, Tazekka and Rass El Ma, the Bou Iblane mountain range, about 60 km from the historic city of Taza (Figure 1).

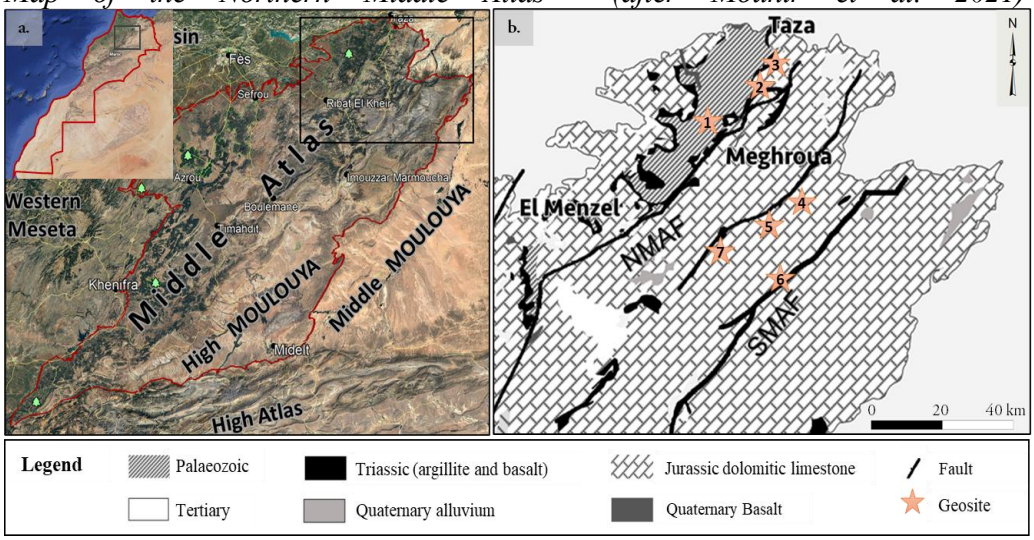
The formations of the Middle Atlas domain are composed essentially of limestone layers, tabulate in the northwest (Middle Atlas plateau) and wavy in the southeast (folded Middle Atlas), while they sometimes exceed 3000 meters in the eastern ridges of the folded domain.

The geomorphology of the eastern Middle Atlas illustrates a vast landscape characterized by the alternation of domes and basins following a general NE-SW orientation, thus revealing the traces of the Atlasic structuring (Mounir et al. 2019). The structural analysis of the Jurassic Atlasic demonstrates a simultaneity between synsedimentary deformations in compression and others in extension, during which the fracturing that affects the region has led to the establishment of several aquifers within the Jurassic carbonate formations (Fedan 1989, Mounir 2020). The genesis of these formations consists of the development of strong hydrothermal activity along fracture surfaces, which triggers the process of dissolution of the carbonates embedded in the Jurassic series (dolomite and limestone with flint or fossils).

In the eastern Middle Atlas, the Tazekka dome-shaped massif (1986 m above sea level), separates a border of plateaus and a folded chain with a NE-SW orientation (Charrière 1990, Charroud 1990, Frizon de Lamotte et al. 2008, Sabaoui 1998). The buttonhole is composed of metamorphic Paleozoic rocks (schist, shales, quartz sandstone).

The study area presents an important geological interest, notably due to the presence of Jurassic carbonate formations that have led to the establishment of several aquifers. The Tazekka massif constitutes a remarkable geomorphological element that deserves to be studied in detail.

Figure 1. *a. Map of Morocco and Location Map of the Study Area. b. Geological Map of the Northern Middle Atlas (after Mounir et al. 2021)*



Methodology

This work aims to valorize the identified geological heritage of the Middle Atlas. The objective is to promote this territory within a national strategic framework of geoconservation, education, and sustainable development (UNESCO 2012; Newsome &Dowling 2018). This approach aligns directly with the priorities of the Moroccan Tourism Roadmap 2023-2026 regarding the development of innovative tourism products and the responsible management of natural sites, while offering new socio-cultural perspectives for the region (OCDE 2024).

The establishment of geosites and geoparks ensures a faithful representation of a region's tangible and intangible wealth from a geoscientific perspective. These initiatives will foster the emergence of new forms of alternative tourism, a modern trend that actively contributes to the socio-economic development of territories.

Through rigorous field investigations and extensive data collection conducted across the Middle Atlas, a set of potential geosites featuring diverse geological characteristics has been identified. These sites are complemented by other attractions of biotic, archaeological, and cultural interest, thereby strengthening the multidisciplinary dimension of the regional heritage.

To structure these results, the site selection and qualification process was based on the methodological approach developed within the framework of our doctoral research (Mounir 2020). This method relies on a precise characterization of scientific and educational values, as well as a vulnerability analysis of the inventoried geological features. Each potential geosite is documented by a detailed inventory sheet, enhanced by 3D plans and models generated via Geographic Information Systems (GIS). These supports consolidate all descriptive, spatial, and justificatory data required to support the relevance and future management of this heritage within the Geopark project.

Tazekka Geosite

The geosite of Tazekka is a dome-shaped inlier that separates a border of karsts and a folded chain with NE-SW orientation. It is located near the Bab Louta dam (Figure 2.a), which offers the public a panoramic view of the vegetation cover of the Tazekka National Park (Mounir et al. 2019).

The geosite also provides a pedagogical opportunity to observe a stratigraphic log that extends from Miocene molasses, Jurassic carbonates, Triassic clays and basalts to the metamorphic Paleozoic formations of the inlier.

The Tazekka massif (1986 m above sea level) is composed mainly of Ordovician schists traversed by quartzite strata and siliceous veins (Martin 1977, Tennevin 1978, Mounir 2020). The Paleozoic basement outcrops to the west and northwest of the village of Bab Boudir (Figure 2.c), which belongs to the Tazekka inlier. This basement is associated with Sb and Pb mineralizations related to the emplacement of Hercynian granitoids and the uplift of the anticlinal massif. The paleontological character of the geosite is represented by fields of ammonites of Domerian age (Gardet & Gérard 1946), located near the mouflon reserve (Figure 2.b.d).

Figure 2. *The Geosite of Tazekka. a. Panoramic View on the Reliefs of the Eastern Middle Atlas and the dam of Bab Louta. b. The Station of the Deer Valley. c. The Black Shales in Crenulation. d. The Ammonite Field*

Ifriouatou Geosite

The Ifriouatou sinkhole, with a depth of 271 meters (Figure 3.a), is considered to be the deepest sinkhole in the region. The resurgences of surface waters in the eastern Middle Atlas are closely linked to fracture networks characteristic of the upper structural style (Mounir et al. 2019).

This is an impressive example of the geomorphosites of North Africa, with a wide diversity of karst forms (avens, caves, sinkholes, dolines, poljes, ponors, underground rivers, or paleokarstic depressions) represented by a subterranean linear feature of 3,500 meters or more in length, since the cave is the outlet of an underground river (Figure 3.b-c).

Figure 3. *a. The Entrance to the Ifriouatou Chasm. b. The Underground Karst Forms of Ifrouatou. c. The Vast Cavities formed in the Cave Circuit*

Chiker Geosite

The Chiker sinkhole (-146 meters) with a length of 3,856 meters, presents the most attractive karst for experienced speleologists (Figure 4.a-b-c). It collects the waters of the Daya Chiker, especially during flood periods, which continue to shape several networks of well-developed underground and surface cavities (avens, caves, sinkholes, dolines, poljes, and underground rivers) (Figure 4.d-e).

The geodiversity and richness of the Jurassic limestone formations make it an important water reservoir in the eastern Middle Atlas (Ek & Mathieu 1964). The karstification process is active in areas of rock weakness, particularly at the intersection of synthetic and antithetic faults (nodes), where the dissolution of carbonates by water is oriented, using the geometrical arrangement of the pre-existing fractures.

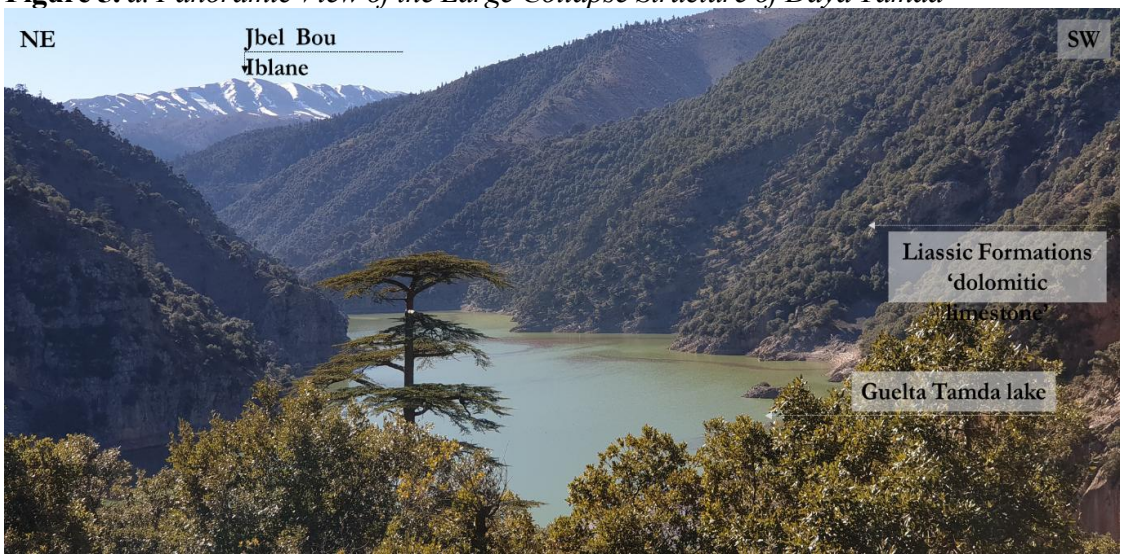
Guelta Tamda Geosite

The Guelta Tamda geosite is located in the Liassic formations, which are composed mainly of dolomite limestone that rests on Triassic clays in the eastern part of the folded Middle Atlas (Figure 5). It is an immense tectonic-karst collapse

of more than 2,000 hectares (more than 100 hectares of floodable area), surrounded by accentuated reliefs (2,000 meters above sea level) covered with forests of green oak and cedar (El Fellah 1994). The natural dam of Guelta Tamda is listed as a site of biological and ecological interest, as it is home to a very abundant diversity of fauna and flora.

Figure 4. *The Chiker Basin during Floods, feeding the Karst. b. The Entrance to Chiker Sinkhole using Stairs. c. The Speleologists Team in search of other Entrances to Caves and training for Amateurs. d-e. The Karstic Structures of the Dayet Chiker Chasms*

Figure 5. *a. Panoramic View of the Large Collapse Structure of Daya Tamda*



Oued El Bared Geosite

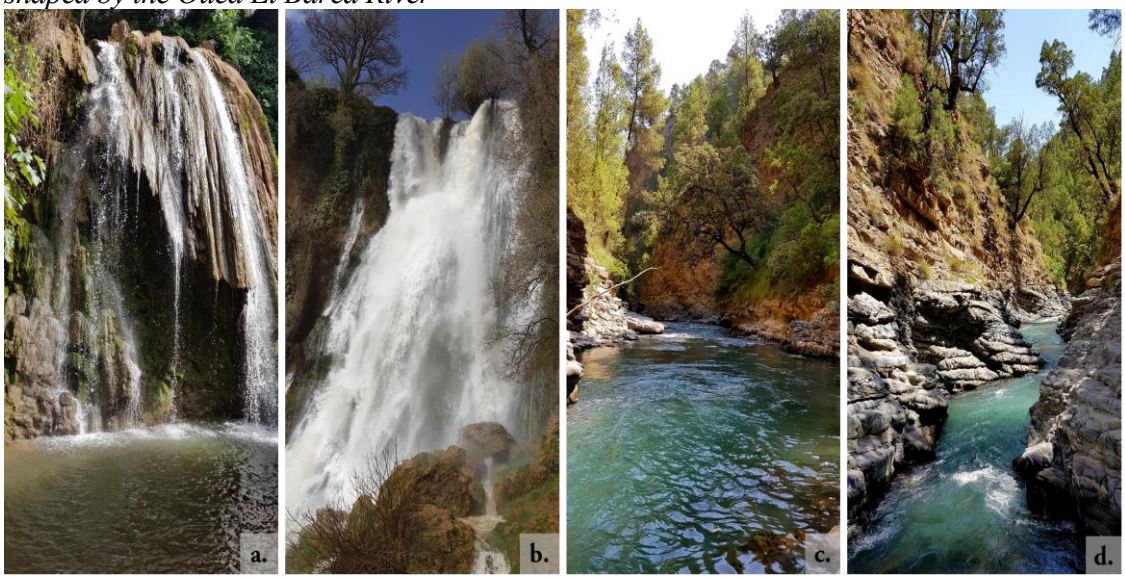
The eastern part of the Middle Atlas has numerous intermittent and perennial watercourses, due to the high rainfall that exceeds 1200mm at Bab Bou Idir and 350mm at Meghraoua, generating rapid runoff and significant hydrological activity (Figure 6-a.b.c.d).

The Oued El Bared linear feature (more than 5 m3/s) represents a striking example of the river hiking trails network, emerging from a cave, several waterfalls, and sparkling gorges (Taous et al. 2009, Mounir et al. 2016, Mounir et al. 2019).

This geosite is of great interest for its geomorphological and ecological features. The river has carved a deep and narrow gorge through the limestone bedrock, creating a spectacular landscape. The gorges are home to a variety of plants and animals, including several species of birds, mammals, and reptiles. The site is also a popular destination for hiking and camping.

The Oued El Bared geosite is a valuable asset for the region. It provides a unique opportunity to learn about the natural history of the Middle Atlas and to enjoy the beauty of the Moroccan countryside.

Figure 6. *The Karstic and Landscape Forms (springs, waterfalls and gorges) shaped by the Oued El Bared River*



Bou Iblane Geosite

The anticlinal structure is affected by two major faults with steep dips (70°) and directions oriented from N50 to N70, belonging to the South Middle Atlas Fault (SMAF), with a small overlap of the fold towards the NW (Sabaoui 1998, Charroud 2002). The NW compartments of the chain are represented by blackish dolomitic slabs and reefal marno-limestones of the Lower Lias, and are represented to the SE by Liassic limestones with Toarcian marls.

The Jbel Bou Iblane is a popular destination for hikers and cavers. It is the second highest peak in the Middle Atlas, with an elevation of over 2,980 meters at Jbel Tanout and 2,920 meters at Jbel Bou Iblane (Figure 7).

Taffert Géosite

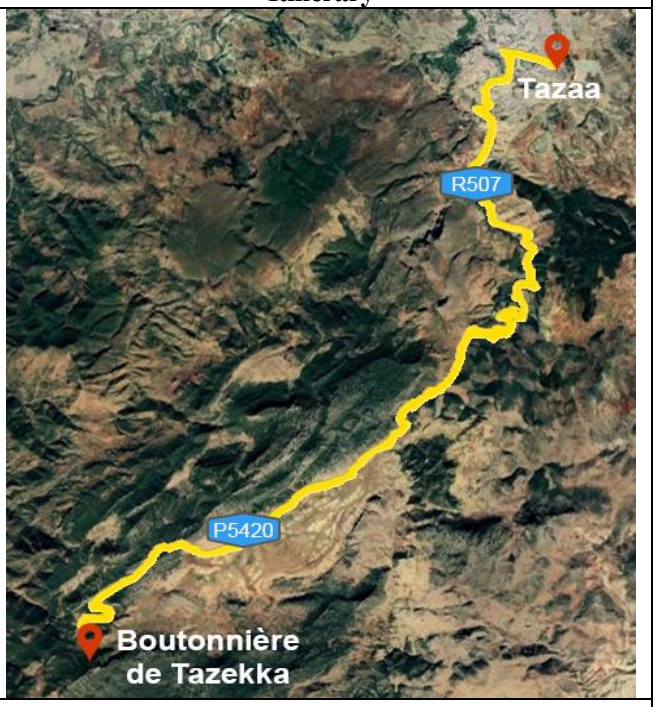
The turbulent waters of the Oued Zloul gorges are undoubtedly among the best rafting routes in the Atlas Mountains. The valley receives rainwater and snowmelt, which it then drains into the main waterways. This drainage has shaped a perfect geomorphological expression of the ultimate stage of karst evolution (Figure 8).

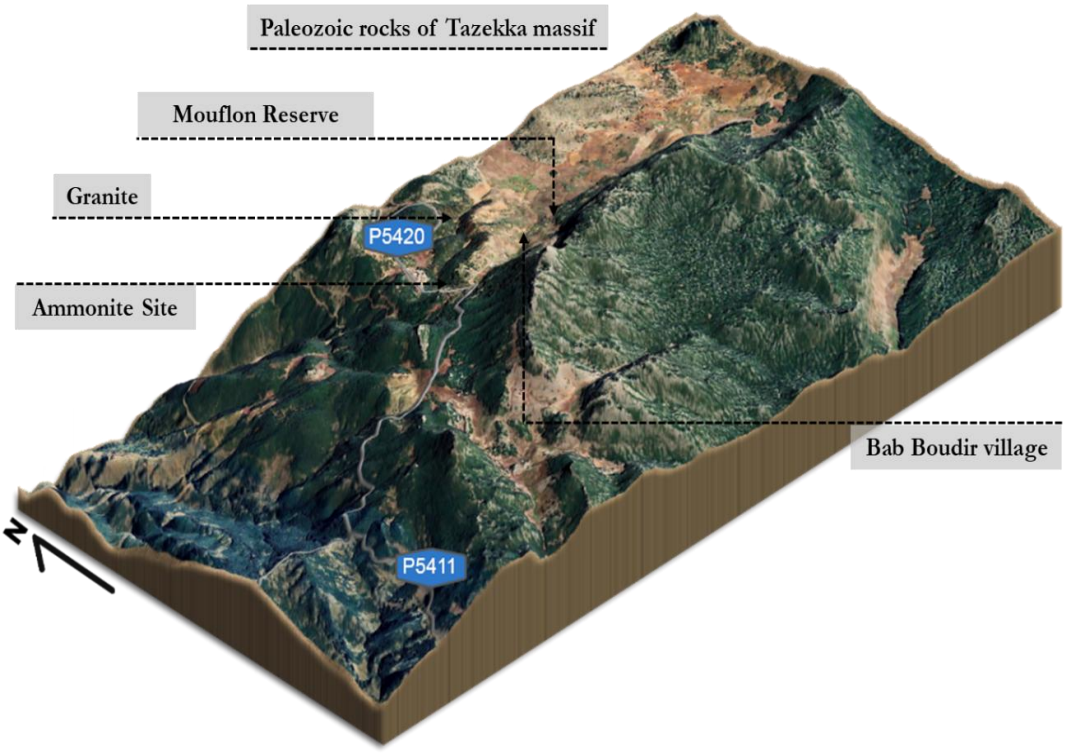
The gorges are also home to exceptional geological characteristics, including rock and reef formations of scientific value. These characteristics include tectonic, geomorphological, and hydrological features.

Figure 7. *a. The Dolomitic and Marlstone Structures of the Lower Lias 'Bou Iblane Massif'*

Figure 8. *The Tectonic-sedimentary Structures of the Taffert Geosite. a. Waterfalls and Gorges of Iouchache. b.The Tamjghyoult Gorges. c. El Jider Canyons*

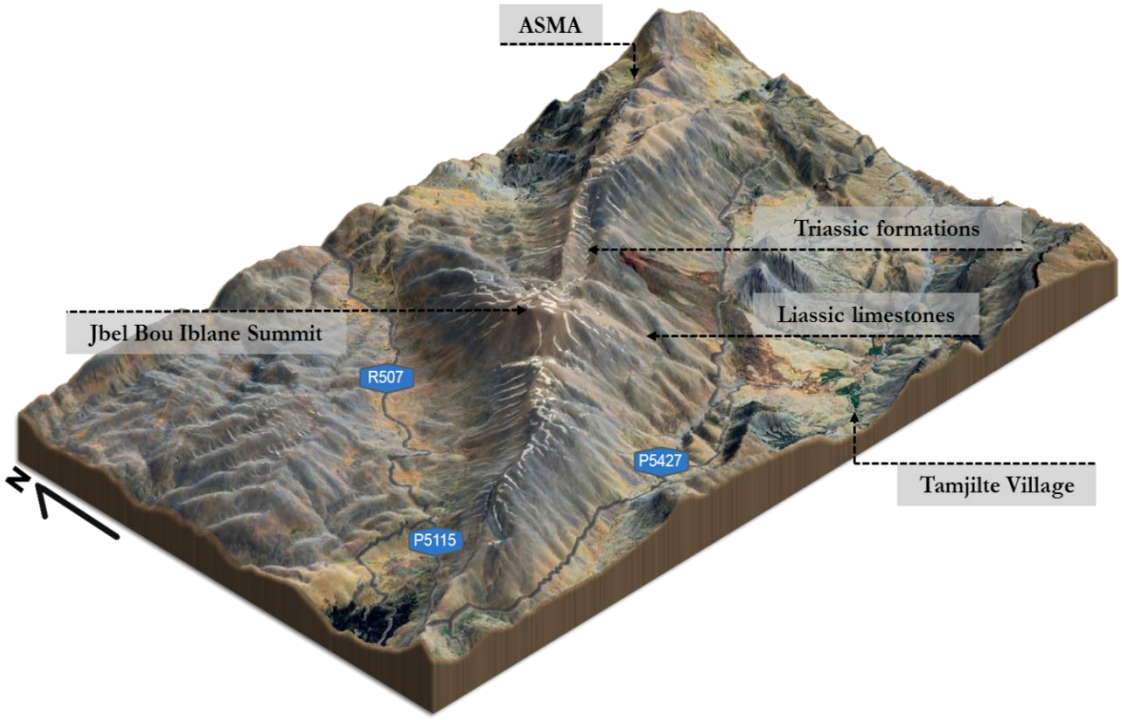
Forms for inventoried Geosites

<table>
<tr><th colspan="2">Identification</th></tr>
<tr><th colspan="2">Geosite: Tazekka</th></tr>
<tr><td>Serial number: GEO 01</td><td>Typology: Geologic (Natural surface site)</td></tr>
<tr><th>Location</th><th>Itinerary</th></tr>
<tr><td>Administrative province: Taza</td><td rowspan="10"> 
</td></tr>
<tr><td>Location: 30 km SW of the city of Taza (Eastern Middle Atlas)</td></tr>
<tr><td>Cartographic references: Topographic map of Taza (1/50.000)</td></tr>
<tr><td>coordinates: 34° 03’ 42" N / -04° 07’ 22"W</td></tr>
<tr><td>Terms and conditions of access</td></tr>
<tr><td>Legal protection: Protected area, such as a natural site within Tazekka National Park.</td></tr>
<tr><td>Accessibilité: the geosite is less than 100 m from the P5420 provincial road.</td></tr>
<tr><td>Observation conditions: Visible from a distance</td></tr>
<tr><th colspan="2">Site description</th></tr>
<tr><td colspan="2">Geological description: The Tazekka massif is part of the eastern inliers of the Middle Atlas, separating the edges of the folded and eastern tabular domains. The Paleozoic terrains of the eastern Middle Atlas form an inlier composed of several series ranging from the Cambrian to the Carboniferous. This dome, rising above 1980 m in altitude, is characterized across most of its area by metamorphosed Paleozoic series of green to purplish and wine-red schists, mudstones, and Ordovician quartzitic sandstones. The geosite offers several observation points for Sb and Pb mineralizations related to the emplacement of Hercynian granitoids and the uplift of the Tazekka massif.</td></tr>
<tr><th colspan="2">Additional interest</th></tr>
<tr><td colspan="2">Variety of geological features: Internal geodynamics, Metamorphism, Plutonism, Structural geology, Geomorphology (karst), Sedimentology and landscape</td></tr>
<tr><td colspan="2">Rarity: National</td></tr>
<tr><td colspan="2">Utility: Geosite of scientific, educational and geotourism interest</td></tr>
<tr><td colspan="2">Fragility and vulnerability: No anthropic or natural threats detected</td></tr>
<tr><th colspan="2">3D model description</th></tr>
</table>

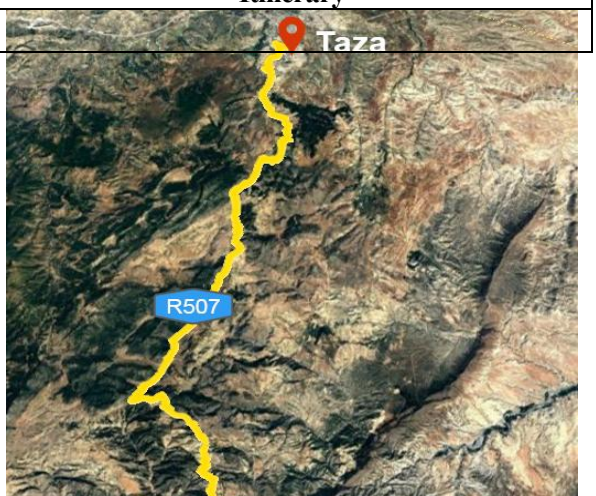


Identification	
Geosite: Bon Iblane	
Serial number: GEO 02	**Typology**: Geological (Structural) and geomorphological
Location	**Itinerary**
Administrative province: Sefrou, Taza	
Location: NE of Imouzzer Marmoucha, 100 km from Taza on the R507 national road (Central Middle Atlas)	
Cartographic references: Topographic map of Ribat El Kheir (1/100.000)	
coordinates: 33° 41’ 30’’N / -04° 03’ 40’’W	
Terms and conditions of access	
Legal protection: Area protected as a Site of Biological and Ecological Interest (SIBE), Taffert Park (Refuge).	
Accessibilité: the geosite is less than 100 m from the R507 regional road.	
Observation conditions: visible from a distance	
Site description	

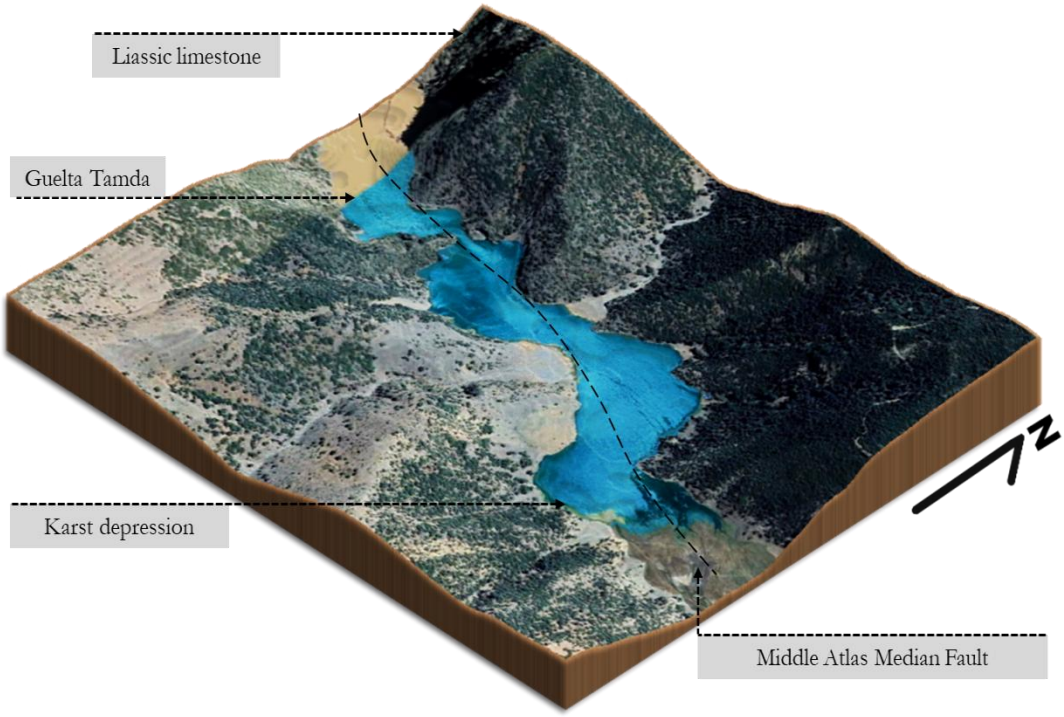
Geological description: The folded Middle Atlas is characterized by brittle and flexible tectonics, in the form of east-west faulted folds corresponding to anticlinal ridges, including the Bou Iblane ridge, which delimits the Taffert and El Mers basins to the northwest and the Berkine and Imouzzar Marmoucha basins to the southwest. The anticlinal structure is affected by two major faults with a steep dip (70°) and orientations of N50° to N70°, belonging to the ASMA (Agglomeration of the Middle Atlas Massif), with a small overthrust of the ridge towards the northwest. This is the second highest mountain range in the Middle Atlas, culminating at over 2980m at Jbel Tanout and 2920m at Jbel Bou Iblane. The northwest compartments of the range are represented by blackish dolomitic slabs and marly limestones of Lower Liassic reef origin, and the southeast compartments by Liassic limestones with Toarcian marls.
Additional interest
Variety of geological features: Structural, Sedimentological, Paleontological and Landscape
Rarity: National
Utility: Geosite of scientific, geotourism (hiking) and educational interest
Fragility and vulnerability: Soil degradation due to water erosion
3D model description



Identification	
Geosite: Guelta Tamda	
Serial number: GEO 03	**Typology** : Hydrologic (Natural surface site)
Location	**Itinerary**
Administrative province: Taza	

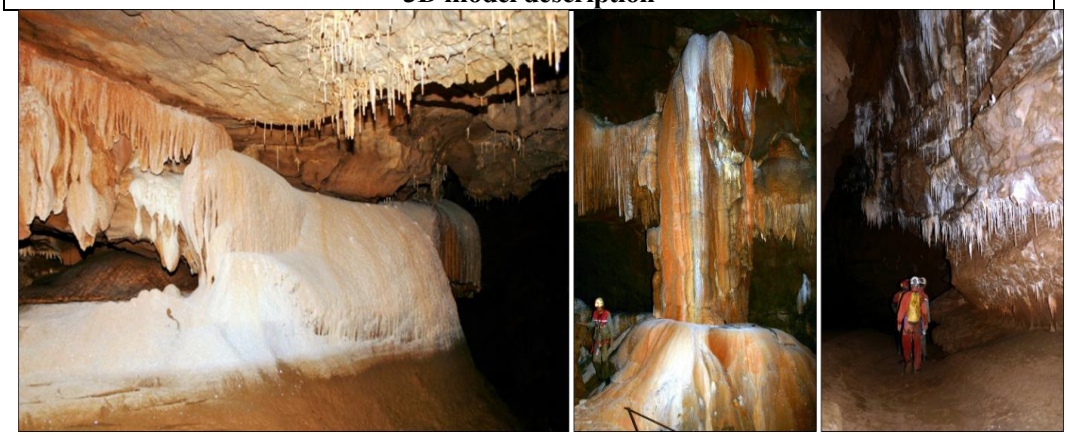


Location: 28 km Sud of Maghraoua village on the R507 regional road linking the city of Taza and Jbel Bouiblane (Eastern Middle Atlas)	
Cartographic references: Topographic map of Maghrawa (1/50.000)	
coordinates: 33° 49' 02" N / -04° 04' 53"W	
Terms and conditions of access	
Legal protection: Protected area, such as a Site of Biological and Ecological Interest (SIBE).	
Accessibilité: The geosite is 5km (on a hiking trail) from the R507 regional road.	
Observation conditions: visible from a distance	
Site description	
Geological description: The Guelta Tamda geosite lies within the Liassic formations, primarily composed of dolomitic limestone resting on the Triassic claystones of the eastern part of the folded Middle Atlas Mountains. It is a vast tectono-karstic collapse covering more than 2,000 hectares (plus an additional 100 hectares of floodplain), surrounded by steep terrain (reaching 2,000 meters in altitude) covered with holm oak and cedar forests. The natural dam of Guelta Tamda is designated as a site of biological and ecological importance, given its abundant faunal and floral diversity.	
Additional interest	
Variety of geological features: Hydrology, karst system, structural and landscape	
Rarity: National	
Utility: Geosite of scientific, educational and geotourism (Hiking) interest	
Fragility and vulnerability: Some traces of degradation from natural erosive activity	
3D model description	



Identification	
Geosite: The Chiker Cave	
Serial number: GEO 04	**Typology**: Karst (Linear, Underground)
Location	**Itinerary**
Administrative province: Taza	
Location: 20 km Sud of the city of Taza (Eastern Middle Atlas)	
Cartographic references: Topographic map of Taza (1/50.000)	
coordinates: 34° 06' 04" N / -04° 03' 01" W	
Terms and conditions of access	
Legal protection: Protected area, such as a natural site within Tazekka National Park.	
Accessibilité: the geosite is less than 100 m from the P5420 provincial road.	
Observation conditions: Limited visibility (Underground site)	

Site description
Geological description: The Chiker Chasm (-146m), with a length of 3856m, presents the most attractive karst landscape for experienced speleologists. It collects the waters of the Daya Chiker, especially during periods of flooding, which continue to shape several extensive networks of underground and surface cavities (sinkholes, caves, chasms, dolines, poljes, and underground rivers). The geodiversity and richness of the Jurassic limestone formations constitute a significant water reservoir in the eastern Middle Atlas, acting on areas of rock weakness, particularly at the intersection of synthetic and antithetic faults (nodes), where the dissolution of carbonates by water occurs in a directed manner, utilizing the geometric pattern of pre-existing fractures.
Additional interest
Variety of geological features: Geomorphology, karst system, structural and landscape
Rarity: National
Utility: Geosite of scientific, educational and geotourism (Hiking) interest
Fragility and vulnerability: Threat of excessive tourism exploitation (Uncontrolled)
3D model description



<table>
<tr><th colspan="2">Identification</th></tr>
<tr><td colspan="2">Geosite: Ifri Ouatou Chasm (Wind Chasm)</td></tr>
<tr><td>Serial number: GEO 05</td><td>Typology: Karst (Linear, Underground)</td></tr>
<tr><th>Location</th><th>Itinerary</th></tr>
<tr><td>Administrative province: Taza</td><td rowspan="9"> 
</td></tr>
<tr><td>Location: 24 km Sud of the city of Taza (Eastern Middle Atlas)</td></tr>
<tr><td>Cartographic references: Topographic map of Taza (1/50.000)</td></tr>
<tr><td>coordinates: 34° 06' 17"N / -04° 04' 21"W</td></tr>
<tr><td>Terms and conditions of access</td></tr>
<tr><td>Legal protection: Protected area, such as a natural site within Tazekka National Park.</td></tr>
<tr><td>Accessibilité: the geosite is less than 100 m from the P5420 provincial road.</td></tr>
<tr><td>Observation conditions: Limited visibility (Underground site)</td></tr>
<tr><th colspan="2">Site description</th></tr>
<tr><td colspan="2">Geological description: The Ifri Ouatou chasm, at -271 m, is considered the deepest chasm in the region. It is an impressive example of North African geomorphosites, due to the great diversity of karst landforms (sinkholes, caves, sinkholes, dolines, poljes, ponors, underground rivers, and paleokarstic depressions) represented by an underground lineament 3,500 m or more in length, as the cave is the outlet of an underground river. The resurgence of surface water in the eastern Middle Atlas is closely linked to the fracture networks characteristic of the upper structural style. The geomorphology of the Middle Atlas is a landscape shaped by groundwater and surface water in Jurassic carbonate terrains, folded and fractured during the Atlas orogeny. This is a domain structured by a succession of synclinal basins separated by fractured anticlinal ridges with a general NE-SW orientation.</td></tr>
<tr><th colspan="2">Additional interest</th></tr>
<tr><td colspan="2">Variety of geological features: Geomorphology, karst system, structural and landscape</td></tr>
<tr><td colspan="2">Rarity: National</td></tr>
<tr><td colspan="2">Utility: Geosite of scientific, educational and geotourism (Hiking) interest</td></tr>
<tr><td colspan="2">Fragility and vulnerability: Threat of excessive tourism exploitation, and some traces of degradation from natural erosive activity</td></tr>
<tr><th colspan="2">3D model description</th></tr>
</table>

Discussion

The elements of geodiversity identified in the Middle Atlas possess a wide spectrum of values, ranging from material (economic, functional, scientific, and educational) to immaterial (intrinsic, cultural, and aesthetic) (Gray, 2013). While visiting areas of exceptional natural beauty is a long-standing practice, geotourism as a formal discipline is centered on leveraging geoheritage to achieve sustainable preservation through education and public engagement (Stoffelen and Vanneste, 2015; Brilha, 2016).

In the specific context of the Middle Atlas, our results highlight several networks of sites with diverse characteristics. These findings align with recent efforts to establish quality labels that guarantee the qualification of the regional offer and promote the dissemination of geotourism (Mounir et al., 2019; Mounir, 2020; Baadi et al., 2021).

This conceptual framework introduces innovative practices and tools—such as the 3D modeling and GIS databases developed in this study—focused on the discovery of territorial heritage resources. This is particularly relevant given that educational institutions and the scientific community in the Fes-Meknes region are increasingly seeking sites that combine high scientific and pedagogical value with practical accessibility. The detailed inventory and spatial representation provided in this work directly address these needs, offering a concrete platform for both academic field trips and sustainable tourism development.

Conclusion

The geological heritage of the Atlas regions currently faces significant threats, including vandalism, the unregulated trade of fossils, and a lack of local awareness regarding the intrinsic value of these Earth archives. Furthermore, uncoordinated territorial development over the last decade has accelerated the degradation of these unique sites.

The diverse geosite elements identified in this study are the result of the complex geological evolution of the Middle Atlas from the Mesozoic to the Quaternary. To safeguard this heritage, we propose to highlight these riches through scientific mediatization and their promotion as a high-quality "Geotourism" product. Our ultimate goal is the establishment of a UNESCO Global Geopark in the Eastern Middle Atlas. Such a framework would provide the necessary scientific and pedagogical structure to assist students, researchers, and the general public in deciphering the history of the Earth as recorded in the Middle Atlas.

In this context, the creation of museum spaces is essential to valorize geoscientific data and meet the demands of natural resource management, territorial planning, and geohazard mitigation. These spaces will serve as concrete levers for regional development. Significant milestones in this direction include the museum inaugurated by geologists from the Faculty of Sciences and Technology of Fez (2013), the Cultural and Natural Heritage Exhibition in Azrou (2016), and the Great Science Museum of the Fez-Meknes region, currently under construction.

By integrating modern tools such as the GIS-based 3D modeling and detailed inventory sheets developed in our doctoral research (2020), this project provides a robust technical foundation for the sustainable management and international recognition of the Middle Atlas heritage.

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Do Forest Fires Deter Tourists? A Dynamic Demand Model for Greek Tourism, 1980–2024

*By Gregory T. Papanikos**

This paper estimates the determinants of international tourist arrivals to Greece over the period 1980–2024, with particular focus on the effect of forest fires. A log-log model identifies four determinants: per capita income of origin countries (elasticity ≈ 3.4, confirming Greek tourism as a luxury good), number of forest fires (elasticity ≈ −0.23), COVID-19 (implying a 57% reduction in arrivals during 2020–2021), and euro adoption (associated with an 18% reduction). A complementary dynamic levels model provides evidence of a nonlinear fire effect, with the deterrent impact strongest at moderate fire frequencies and diminishing beyond a turning point of approximately 1,854 fires per year. Area burned is not statistically significant, suggesting that fire frequency — and its associated media coverage — rather than fire severity drives visitor deterrence. The findings carry direct implications for environmental, competitiveness and crisis management policy in tourism-dependent economies.

Keywords: *forest fires; international tourism demand; Greece; income elasticity; nonlinear effects; dynamic model; time-series analysis*

Introduction

International tourism is a major income-generating sector of the Greek economy. In 2024, tourism receipts reached a record €21.6 billion, and arrivals totaled 40.7 million, accounting for 8.4% of GDP (Bank of Greece). While previous studies have highlighted the roles of income, relative prices, exchange rates, and exceptional events such as geopolitical crises and pandemics in shaping tourism flows (Lim 1997, Crouch 1994), one potentially important determinant has been largely overlooked in quantitative demand analyses: the occurrence of forest fires.

This omission is notable for two reasons. First, in southern Europe, the peak tourist season coincides with the period of highest fire risk, and Greece has experienced some of the most destructive wildfires on record, including the 2007 Peloponnese fires (225,734 hectares), the 2021 Evia fire (108,418 hectares), and the 2023 Evros fire (136,499 hectares), the largest single fire event in EU history (European Commission, 2025). Second, international media coverage of fires is extensive, and there is strong reason to expect that such coverage influences destination image and booking decisions. To date, however, no study has directly estimated the effect of forest fire frequency on international tourist arrivals to Greece or, to the author's knowledge, any country using a national time-series framework.

The closest antecedent is Otrachshenko and Nunes (2022), who use panel data for 278 Portuguese municipalities over 2000–2016 and find that a 1% increase in burned area reduces inbound arrivals by 1.12%. Their study focuses on area

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burned at the sub-national level; the present paper differs in three important respects. First, it models fire frequency (number of fires) rather than — or alongside — area burned, and finds that frequency is the empirically relevant variable while area burned is not statistically significant, a distinction with direct policy implications. Second, it employs a national aggregate time-series approach over a 45-year horizon, capturing long-run structural forces alongside short-run dynamics. Third, it tests explicitly for nonlinearity in the fire effect, allowing the marginal deterrent impact to vary with the level of fire activity.

This paper makes three specific contributions. First, it provides the first estimates of the elasticity of international tourist arrivals with respect to forest fire frequency, using annual data for Greece from 1980 to 2024. Second, it incorporates this variable within a comprehensive demand model that simultaneously accounts for foreign income, relative prices, euro adoption, and the COVID-19 shock, employing HAC-robust standard errors to address residual autocorrelation. Third, it uses a dynamic levels specification with quadratic fire terms to test whether the deterrent effect of fires is constant — as assumed by a log-log model — or diminishes at high fire frequencies, finding suggestive evidence of the latter, with an empirically meaningful turning point of approximately 1,854 fires per year.

The remainder of the paper is structured as follows. The next section analyses the time series of forest fires and burned area in Greece over the sample period. The third section presents the empirical specifications and discusses the role of each variable. The fourth section reports the estimation results, comparing the log-log and dynamic levels models. The fifth section discusses policy implications, and the sixth section concludes.

Forest Fires and burned area in Greece, 1980–2024

This section provides a descriptive synopsis of the two-fire series used in the empirical analysis — the annual number of forest fires and the total area burned (hectares) — drawing on data from the European Commission's annual reports on forest fires in Europe (European Commission, 2025). Figures 1 and 2 display the full time series from 1980 to 2024, and Table 1 presents summary statistics.[1]

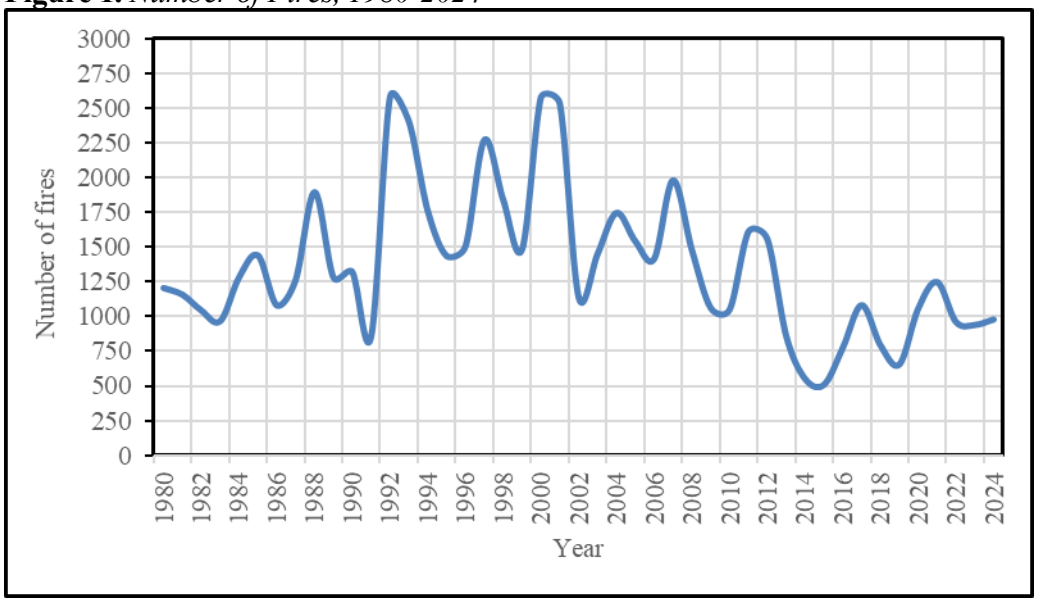
Visual Inspection

Figure 1 shows that fire frequency in Greece is highly volatile, with no simple linear trend over the 45-year period. Two distinct peaks are visible: 1992–1993 and 2000–2001, both exceeding 2,500 fires per year. The 2010s saw a pronounced and sustained decline, with the series reaching its sample minimum of 510 fires in

[1]The literature on forest fires extensively addresses aspects such as prevention, management, evacuation, and restoration. While some studies discuss the impacts of fires on tourism, they do not quantify these effects as this study does (e.g., Boustras and Boukas, 2013; Diaz, 2012; Fernandes et al., 2025; Molina-Terrén et al., 2019; Neger et al., 2024; Ritchie, 2004). Several of the issues highlighted in these studies are revisited in the policy section of this paper.

2014, before a partial rebound in the 2020s driven by prolonged heatwaves and drought conditions associated with climate change.

Figure 1. *Number of Fires, 1980-2024*



Source: https://forest-fire.emergency.copernicus.eu/reports-and-publications/annual-fire-reports

Figure 2 reveals a weaker relationship between fire count and burned area than might be expected. The 1990s, despite recording the highest fire frequencies, produced moderate burned areas, while 2007 stands alone as a catastrophic outlier at 225,734 hectares — the result of the devastating Peloponnese fires. The 2020s have introduced a new pattern of mega-fires: the 2021 Evia fire (108,418 ha) and the 2023 Evros fire (136,499 ha, the largest single fire event in EU recorded history) suggest that Greece is entering an era of fewer but vastly larger events, driven by extreme heat and drought rather than high ignition frequency.

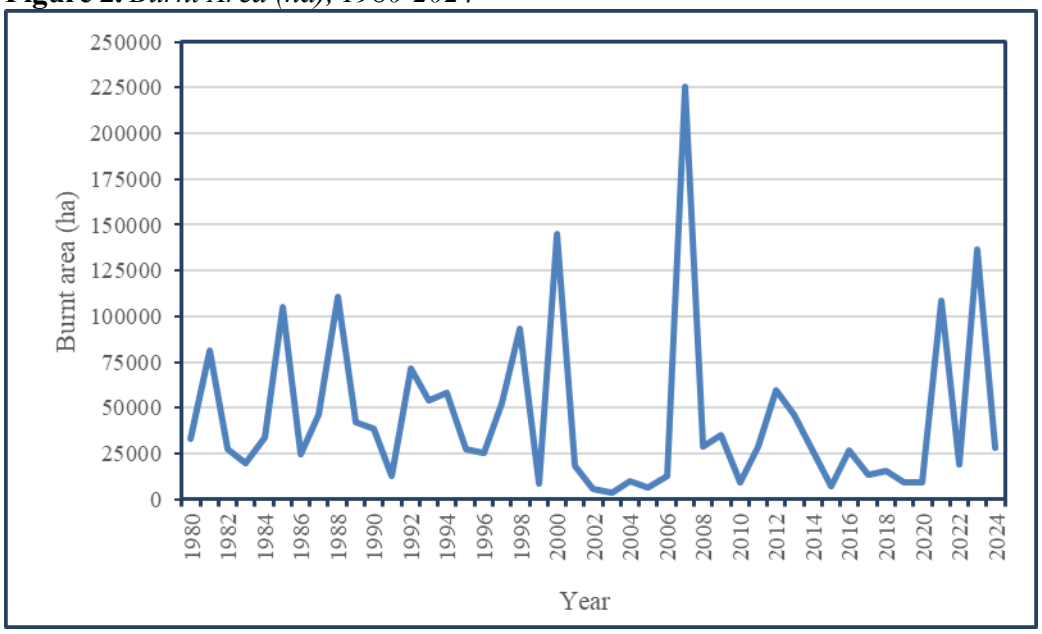
Summary Statistics

As shown in Table 1, the number of fires averages 1,371 per year with a standard deviation of 524, and the distribution is only mildly right-skewed (skewness = 0.78, kurtosis = 3.11). The Jarque-Bera test does not reject normality ($p = 0.10$), confirming that fire frequency fluctuates around a roughly stable mean — a prerequisite for treating the variable as stationary in the empirical model.

The burned area series has markedly different distributional characteristics. The mean of 44,470 ha is far above the median of 28,288 ha, reflecting the influence of a small number of extreme years. The standard deviation (45,163 ha) actually exceeds the mean, implying a coefficient of variation above unity — an extraordinary level of dispersion. Skewness of 2.00 and kurtosis of 7.45 confirm a heavily right-tailed distribution, and the Jarque-Bera statistic of 67.38 ($p < 0.001$) overwhelmingly rejects normality. This distributional difference between the two series is relevant to the regression results: fire frequency, which is approximately normally distributed

and stationary, proves to be a more reliable predictor of tourism arrivals than burned area, which is dominated by a handful of outlier observations.

Figure 2. *Burnt Area (ha), 1980-2024*



Source: https://forest-fire.emergency.copernicus.eu/reports-and-publications/annual-fire-reports

Table 1. *Summary Statistics of Total Number of Fires and Area Burned, 1980–2024*

Statistic	Number of Forest Fires	Area Burned (ha)
Mean	1,371	44,470
Median	1,284	28,288
Maximum	2,582	225,734
Minimum	510	3,517
Std. Dev.	524	45,163
Skewness	0.78	2.00
Kurtosis	3.11	7.45
Jarque-Bera	4.61	67.38
(Probability)	(0.1)	(0.00)
Observations	45	45

Notes: Number of fires refers to the total annual count of forest fires incidents recorded in Greece (European Commission, 2025). Area burned is measured in hectares. The Jarque-Bera statistic tests the null hypothesis of normality; it is rejected at the 5% level for number of fires ($p = 0.01$) and at the 1% level for area burned ($p < 0.01$), the latter reflecting strong positive skewness (2.00) and substantial excess kurtosis (7.45) driven by catastrophic fire years such as 2007.

Stationarity

Unit root tests confirm that both series are stationary. For the number of fires, the Augmented Dickey-Fuller (ADF) test rejects the null hypothesis of a unit root when an intercept is included ($t = -3.56$), indicating stationarity around a constant mean — consistent with the absence of a visible deterministic trend in Figure 1. Similar results are obtained for burned area. Both series can therefore be used directly in the regression without differencing, and the inclusion of lagged dependent variables in the dynamic specification is justified on economic rather than statistical grounds.

The Empirical Specification

In this section, we present the empirical specifications and discuss the effects of the explanatory variables. The parameter estimates are presented in the next section.

The Two Specifications

In this paper we use two specifications: a log-log specification and a dynamic nonlinear specification. To estimate their effect on international arrivals to Greece, we employ the following empirically motivated and parsimonious models.

$$\log(ITA_t) = \alpha + \beta_1 \log(F_t) + \beta_2 \log(Y^w)_t + \beta_3 \log(P^w/P^g)_t + \beta_4 \mathbf{D}_t + \varepsilon_t \quad (1)$$

$$ITA_t = \alpha + \beta_1 ITA_{t-1} + \beta_2 ITA_{t-2} + \beta_3 T_1 + \beta_4 T_2 + \beta_5 F_t + \beta_6 (F_t)^2 + \beta_7 \Delta(Yw)_t + \beta_8 (P^w/P^g)_t + \beta_9 \mathbf{D}_t + \varepsilon_t \quad (2)$$

where:

ITA_t = Total foreign tourist arrivals to Greece in year (t)
F_t = The number of forest fires in year (t)
$(Y^w)_t$ = Average per capita GDP of USA, UK, Germany and France in period (t)
$(P^w/P^g)_t$ = The ratio of the average price level of the four countries relative to Greek price level in period (t)
T_1, T_2 = Time trend variables
Dt = A vector of dummies to be discussed in the next section
ε_t = Disturbance term
α = Constant term
$\beta_1, \ldots, \beta_9$ = Estimated coefficients

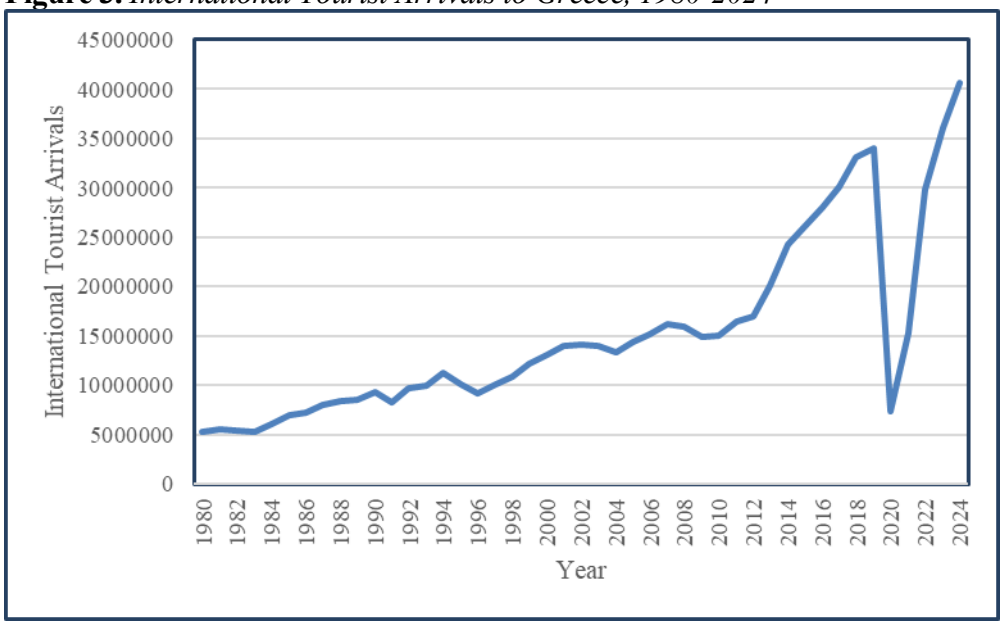
Specification (1) is considered the standard model for the reasons explained in the next section. The two specifications are estimated using Greek data from 1980 to 2024, and the results are reported in the following section. The remainder of this section examines the role of the variables in the two empirical specifications.

The Dependent Variable: International Tourism Arrivals to Greece

The dependent variable is the number of international tourists arriving in Greece (ITA). Figure 3 shows ITA from 1980 to 2024. Arrivals increased gradually from 5.3 million to about 14.2 million, roughly doubling over two decades, with only minor dips (notably in 1991, likely tied to the dampening effect of the Gulf War on travel). The post-9/11 environment, the 2004 Athens Olympics (Papanikos 1999), and the onset of the Greek economic crisis kept arrivals in the 13–17 million range for almost a decade. Overall, growth was relatively flat.

The period 2013–2019 represents the most striking phase. Arrivals nearly doubled, rising from 20 million to 34 million in just six years. The economic crisis ironically contributed by lowering the cost of visiting Greece, while the country simultaneously invested in tourism promotion. As a result, Greece emerged as one of Europe's top destinations.

Figure 3. *International Tourist Arrivals to Greece, 1980-2024*



Source: National Statistics of Greece and Bank of Greece

The year 2020 was catastrophic — arrivals fell to just 7.4 million, a drop of approximately 78%, marking the lowest level since the mid-1980s (Papanikos 2020, 2022b). The recovery was swift: by 2022, Greece had nearly returned to pre-pandemic levels, and by 2023–2024, it surpassed all previous records, reaching 40.7 million in 2024.

In conclusion, Greece's tourism has been a remarkable growth story, particularly in the last decade. The 2024 figure of roughly 40.7 million represents an almost 20% increase over the pre-pandemic peak of 2019, indicating that the sector has fully recovered and entered a new phase of expansion. Going forward, the key challenge will be managing the pressures of overtourism, especially in popular destinations such as Santorini, Mykonos, and Athens.

ITA is trend-stationary. Unit root tests indicate that the series becomes stationary only when both a constant and a deterministic trend are included, with a t-statistic of −4.32, significant at conventional levels. This confirms that ITA_t exhibits a systematic upward movement over time, reflecting the long-term growth of Greece's tourism sector. Consequently, including lagged values of the series in regression models is justified, and inference based on these regressions is valid, as the residuals do not display unit root behavior. The results also suggest that shocks to international tourist arrivals have only temporary effects relative to the deterministic trend.

Trends

To account for structural changes over the sample period (1980–2024), specification (2) includes two separate time trends:

1. **T_1 (1980–2010):** captures the historical growth trend in tourism prior to the economic crises of the 2010s.
2. **T_2 (2011–2024):** captures the more recent trend, including recovery and expansion following the crisis.

Including these trends in the dynamic model ensures that the deterministic growth pattern in tourist arrivals is properly modeled, preventing spurious regression results. The two trend periods (T_1 and T_2) allow us to assess whether the long-term growth rate of tourist arrivals differs between the historical (1980–2010) and post-crisis (2011–2024) periods.

The Effect of Forest Fires on Tourism

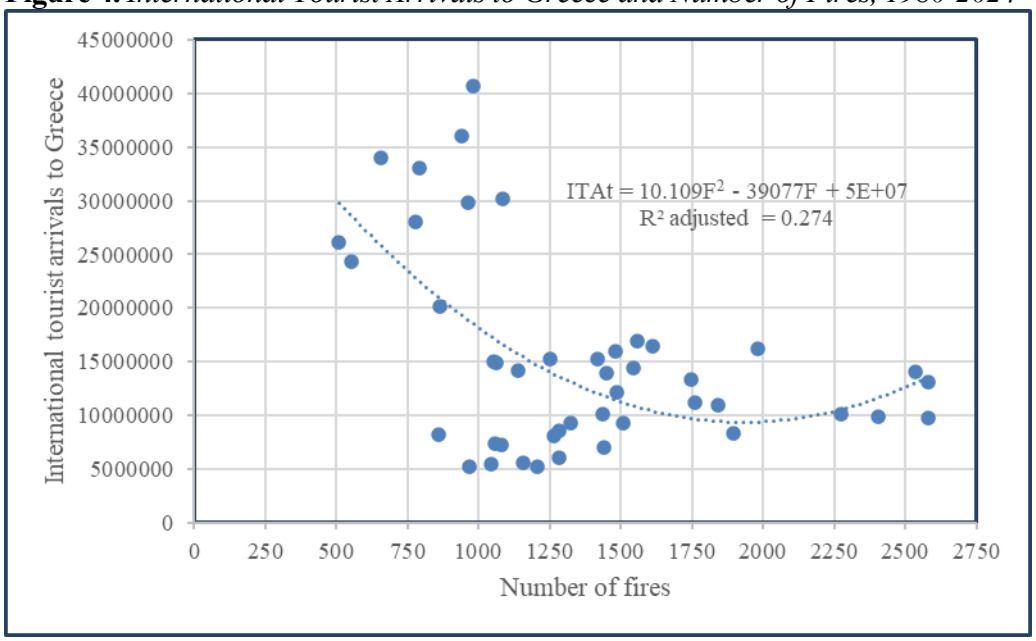
In specification (1), forest fire elasticity is assumed constant. In the dynamic specification, forest fires (F) are modeled nonlinearly, using both a linear term ($\beta_5 F_t$) and a quadratic term ($\beta_6 (F_t)^2$), allowing the impact on total tourist arrivals (ITA) to vary with fire severity. In the short run, more fires reduce arrivals, with larger effects as fire frequency increases, reflecting heightened safety concerns and reduced destination attractiveness. In the long run, this negative impact is amplified by the persistence of arrivals captured by lagged dependent variables, indicating that severe fires can depress tourism over multiple years. Figure 4 shows a scatter plot of international arrivals and fires, which visually supports a nonlinear relationship, justifying the quadratic specification in (2).

Foreign real per capita GDP in source countries is a key determinant of Greek international tourism arrivals, as it reflects the purchasing power of potential tourists and their ability to afford international travel. Higher real income increases the affordability of trips, generally leading to more arrivals, while lower income is associated with reduced travel demand.

The ratio of the foreign CPI to Greek CPI, conditional on real per capita GDP, primarily captures relative price changes between Greece and the source countries. A higher ratio can make Greece relatively cheaper in nominal terms, enhancing its

price competitiveness and potentially increasing tourism arrivals. Conversely, if Greek prices rise proportionally, the effect may be negligible.

Figure 4. *International Tourist Arrivals to Greece and Number of Fires, 1980-2024*



Per Capita Foreign Income and relative Consumer Price Indices (CPI)

Overall, the net impact of these macroeconomic variables reflects two distinct channels: the positive income effect captured by real GDP per capita and the price competitiveness effect captured by foreign inflation. While the effect of foreign income is expected to be positive, the effect of foreign inflation is theoretically ambiguous and depends on the relative evolution of prices between Greece and the tourists' home countries.

Empirical Results

This section presents the estimation results of Equations (1) and (2). First, we discuss the sources and limitations of data followed by the parameter estimates of the model.

Sources and Limitations of Data

Data on international tourist arrivals to Greece are obtained from two national sources: the National Statistics Office of Greece (ESYE) for the period 1980–2005 and the Bank of Greece for 2006–2024. These data include only overnight visitors and are available from 1995 onward. The series has been revised multiple times, and several breaks are present due to changes in methodology. To assess whether these limitations affect the empirical findings, we test the time series separately for

the periods before and after 1995 and apply tests for structural breaks in specific years. No evidence of such breaks was found.

Data on the number of fires and the forest area burned, measured in hectares, are reported in a publication by the European Commission (2025) and are available from 1980 onward.

Data on GDP per capita, along with exchange rates and consumer prices, are obtained from the World Development Indicators of the World Bank. Ideally, we would use a weighted average of GDP per capita and inflation across all countries, weighted by their share of international arrivals to Greece. However, such data are unavailable. Instead, we use data from four main source countries—the United States, the United Kingdom, Germany, and France—and compute a simple average. We apply the same procedure to the Consumer Price Index (CPI), averaging the CPI of these four source countries. We consider these variables to be good proxies for per capita GDP and CPI relevant to Greek tourism.

Summary Statistics

Table 2 presents summary statistics of the continuous variables used in the estimation. The summary statistics reveal substantial variation across the four variables, reflecting differing distributional characteristics and degrees of volatility. International tourist arrivals (ITA) exhibit a relatively high mean of approximately 15.3 million and a median of 13.3 million, indicating that the distribution is influenced by higher values in later years. This is supported by the positive skewness (1.19), suggesting a right-tailed distribution in which periods of exceptionally high tourism inflows pull the mean above the median. The relatively large standard deviation (9.15 million) confirms significant variability over the sample period, likely reflecting structural changes in tourism demand and external shocks. The Jarque–Bera statistic is statistically significant ($p = 0.004$), indicating deviation from normality.

The number of fires (F) has a mean of 1,371 and a median of 1,284, with moderate dispersion (standard deviation $\approx$ 523). The positive skewness (0.78) indicates that years with unusually high fire incidence occur, but they are not extreme. The Jarque–Bera probability ($p \approx 0.10$) suggests that normality cannot be rejected at conventional significance levels, implying a relatively symmetric distribution compared with the other variables.

The analysis of average per capita GDP (Y^w) for the United States, United Kingdom, Germany, and France from 1980 to 2024 indicates a relatively stable and moderately dispersed growth pattern. Over the 45-year period, the mean GDP per capita is approximately 38,189 USD, slightly below the median of 39,639 USD, reflecting a small negative skew in the distribution. The standard deviation of 7,509 USD and a range spanning from 25,338 USD to 49,507 USD suggest moderate variability across the years, while the kurtosis of 1.80 indicates a slightly flatter-than-normal distribution. The Jarque-Bera test fails to reject the null hypothesis of normality ($p = 0.20$), confirming that the GDP per capita data are approximately normally distributed with only minor deviations due to occasional lower GDP values.

Table 2. *Summary Statistics of the Continuous Variables Used in the Regression, 1980–2024*

	ITA	F	Y^w	P^w/P^g
Mean	15,255,926	1,371	38,189	1.46
Median	13,313,000	1,284	39,639	1.13
Maximum	40,693,879	2,582	49,507	3.15
Minimum	5,258,372	510	25,338	0.99
Std. Dev.	9,147,606	523	7,509	0.65
Skewness	1.19	0.78	−0.26	1.57
Kurtosis	3.48	3.11	1.8	4.06
Jarque-Bera	11.06	4.61	3.21	20.46
Probability	0.004	0.1	0.2	0.0000
Observations	45	45	45	45

Notes: ITA = international tourist arrivals to Greece; F = number of forest fires in Greece; Y^w = average per capita GDP of the United States, United Kingdom, Germany and France (constant 2015 USD); P^w/P^g = ratio of the average CPI of origin countries to the Greek CPI. The Jarque-Bera statistic tests the null hypothesis of normality; rejection at conventional significance levels is indicated for ITA ($p = 0.004$) and P^w/P^g ($p < 0.001$).

The ratio of the average consumer price index of the four main origin countries to the Greek CPI (P^w/P^g) serves as a measure of the relative price competitiveness of Greece as a tourist destination. A value greater than unity indicates that prices in the origin countries are, on average, higher than in Greece, implying a cost advantage for Greek tourism. The descriptive statistics reveal that the variable has a mean of 1.46 and a median of 1.12 over the sample period 1980–2024, confirming that Greece has generally been a relatively affordable destination for visitors from the United States, the United Kingdom, Germany and France. The range is, however, considerable: the series reaches a maximum of 3.15 and a minimum of 0.99. The standard deviation of 0.65 reflects substantial variation over time, driven largely by the inflationary episodes of the 1980s, the post-2010 internal devaluation period in Greece, and the sharp divergence in inflation rates between Greece and its origin markets during the energy crisis of 2021–2023. The distribution is positively skewed (skewness = 1.57) with excess kurtosis (4.05), and the Jarque-Bera statistic of 20.46 ($p < 0.001$) formally rejects the null hypothesis of normality, indicating that the series is characterized by occasional large upward spikes rather than symmetric fluctuations around its mean. This asymmetry is consistent with the view that episodes of strong Greek price competitiveness — most notably during the post-2010 fiscal adjustment — were exceptional rather than typical features of the sample.

The Log-log Specification

The estimation results of the log-log specification are presented in Table 3. The model explains approximately 94.4 per cent of the variation in international tourist arrivals to Greece over the period 1980–2024 ($R^2 = 0.944$), with an adjusted R^2 of 0.937, indicating a very good overall fit. Given evidence of residual autocorrelation — the Durbin-Watson statistic of 1.379 falls below the conventional threshold — all inference is based on heteroskedasticity- and autocorrelation-consistent (HAC) standard errors following the Newey-West procedure with a fixed bandwidth of four lags. Column (2) of Table 1 reports conventional OLS t-statistics as a robustness check; since the two columns yield qualitatively identical conclusions for all variables except $\log(P^w/P^g)$ and EURO, the discussion below focuses on the preferred HAC specification.

Income of Origin Countries

The income variable, measured as the average per capita GDP of the four principal origin markets (United States, United Kingdom, Germany and France), enters with a coefficient of 3.4 and is highly significant under both specifications ($t = 6.314$ under HAC; $t = 12.310$ under OLS). The estimated income elasticity of demand for Greek tourism thus exceeds unity by a substantial margin, confirming that international travel to Greece behaves as a luxury good. This finding is consistent with the broader tourism demand literature, where income elasticities above two are commonly reported for Mediterranean destinations (e.g. Lim 1997, Crouch 1994). The magnitude of the estimate implies that a sustained one per cent increase in real incomes in the origin countries is associated, on average, with a 3.4 per cent increase in arrivals to Greece, underscoring the high sensitivity of Greek tourism revenues to business cycle conditions abroad.

Environmental Quality: Forest Fires

The number of forest fires in Greece, used as a proxy for environmental degradation and negative destination publicity, carries a coefficient of −0.228 and is statistically significant at the one per cent level under both specifications ($t = -2.622$ under HAC; $t = -3.337$ under OLS). The negative elasticity implies that a ten per cent increase in the number of fires reduces tourist arrivals by approximately 2.3 per cent. Based on 2024 arrivals of 40.69 million, this elasticity corresponds to a reduction of nearly one million tourists. Assuming an average expenditure of €500 per tourist, this decline would result in a revenue loss of approximately €500 million.

The finding aligns with the destination image literature, which documents that natural disasters and environmental incidents generate persistent negative media coverage that deters prospective visitors (Ritchie, 2004; Papatheodorou et al., 2010).

The COVID-19 Effect

The COVID-19 dummy variable, which takes the value of one for the years 2020 and 2021, produces the largest estimated effect in the model.[2] The coefficient

[2]The impact of COVID-19 has been examined by Boutsioli et al. (2022a, 2022b), Jones (2022), Jones and Comfort (2020), and Papanikos (2020, 2022b).

of −0.849 is highly significant under both specifications (t = −6.934 under HAC; t = −8.018 under OLS) and implies a reduction in tourist arrivals of approximately 57 per cent during the pandemic years relative to the counterfactual [$e^{-0.849} - 1 \approx -0.572$]. This estimate is consistent with official data showing that international arrivals to Greece collapsed from approximately 31 million in 2019 to fewer than 8 million in 2020, before partially recovering in 2021. The inclusion of the COVID dummy also serves to isolate the structural break introduced by the pandemic, thereby protecting the estimates of the other coefficients from contamination by this exceptional event.

Relative Price Competitiveness

The relative price variable, defined as the ratio of the average consumer price index of the four origin countries to the Greek CPI, carries a positive coefficient of 0.332, consistent with the expected sign: when prices abroad rise relative to Greece, the destination becomes relatively cheaper and more attractive to foreign visitors. Under the preferred HAC specification, the coefficient is not statistically significant at conventional levels (t = 1.516, p = 0.138); however, it becomes significant at the one per cent level under conventional OLS standard errors (t = 2.780, p = 0.008).

The discrepancy between the two columns for this variable is attributable to the presence of autocorrelation in the residuals, which inflates OLS precision. The HAC result is therefore the more reliable basis for inference. The absence of robust price significance may reflect the well-documented difficulty of measuring tourism price competitiveness with aggregate CPIs, which capture a broader consumption basket than the goods and services typically consumed by tourists. Alternatively, it may indicate that demand for Greek tourism is driven primarily by income and destination image rather than relative price levels, a pattern also noted by Dritsakis (2004) for the Greek case.

Euro Adoption

The euro dummy variable, which takes the value of one from 2002 onwards, carries a negative coefficient of −0.203. Under the HAC specification the variable is marginally significant at the ten per cent level (t = −1.939, p = 0.060), while under OLS it is significant at the five per cent level (t = −2.277, p = 0.028). The negative sign suggests that euro adoption was associated with a reduction in tourist arrivals of approximately 18 per cent [$e^{-0.203} - 1 \approx -0.184$], after controlling for income, prices and other factors.

This result is likely driven by the real appreciation of the Greek economy following monetary union (Papanikos 2015, 2022a). With the exchange rate no longer adjustable, rising costs of living could not be offset by currency depreciation, reducing price competitiveness relative to non-eurozone destinations. This aligns with evidence from other eurozone studies, which indicate that adopting the common currency had an ambiguous effect on inbound tourism in peripheral member states (Santana-Gallego et al. 2010).

Robustness

To assess the stability of the baseline results, the model was also estimated

excluding the relative price variable log(P^w/P^g) (not reported in the table). The restricted specification yields an adjusted R^2 of 0.926, compared with 0.937 in the full model, and a higher Akaike Information Criterion (−0.834 versus −0.971), indicating a worse fit. Moreover, the coefficient on EURO loses significance (p = 0.103), consistent with the conceptual overlap between the price ratio and euro adoption as measures of cost competitiveness. The core results — the income elasticity, the fires coefficient and the COVID effect — are qualitatively unaffected by the exclusion, confirming the robustness of the main findings. On balance, the evidence favors retaining the full specification.

Table 3. *Determinants of International Tourism Arrivals to Greece, 1980–2024 Dependent variable: LOG(ITA). Observations: 45*

Variable	Coefficient	(1) HAC t-statistic	(2) OLS t-statistic
Constant	−17.994	−3.013***	−5.982***
LOG(F)	−0.228	−2.622**	−3.337***
LOG(Y^w)	3.424	6.314***	12.310***
COVID	−0.849	−6.934***	−8.018***
LOG(P^w/P^g)	0.332	1.516	2.780***
EURO	−0.203	−1.939*	−2.277**
R-squared		0.944	0.944
Adjusted R-squared		0.937	0.937
S.E. of regression		0.140	0.140
Akaike info criterion		−0.971	−0.971
Durbin-Watson stat		1.379	1.379

Notes: All continuous variables are in natural logarithms. ITA = tourist arrivals; F = forest fires; Y^w = average per capita GDP of US, UK, Germany and France; COVID = dummy for 2020–2021; P^w/P^g = ratio of average CPI of origin countries to Greek CPI; EURO = dummy for euro adoption years. Column (1) reports t-statistics based on HAC standard errors (Bartlett kernel, Newey-West fixed bandwidth = 4), which are robust to heteroskedasticity and autocorrelation and constitute the preferred specification given evidence of residual autocorrelation (Durbin-Watson = 1.379). Column (2) reports conventional OLS t-statistics and is included as a robustness check; coefficients are identical across both columns. Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.10.

Modeling Nonlinearity in the Fire Effect: A Dynamic Levels Approach

As a complement to the log-log specification, Table 4 presents an alternative model estimated in levels with a dynamic autoregressive structure and quadratic fire terms as has been discussed in the previous section.

The model includes two lags of the dependent variable, ITA(−1) and ITA(−2), a piecewise linear time trend to capture structural breaks in the long-run growth path of arrivals, the number of fires and its square, per capita income of the origin countries, and the relative price ratio. The specification is estimated with HAC standard errors over 43 observations after lag adjustments, and ITA has been confirmed to be stationary in levels through unit root testing, validating the use of OLS in this framework.

Dynamic Adjustment and Trend

The two lagged dependent variables are both highly significant (t = 6.101 and t = −6.142 respectively, both $p < 0.001$), confirming the presence of substantial persistence in tourist arrivals. The positive coefficient on ITA(−1) and negative coefficient on ITA(−2) together imply a second-order autoregressive process in which arrivals adjust gradually toward their equilibrium level, reflecting the well-documented inertia in tourism demand driven by repeat visitation, established travel patterns, and the slow adjustment of tour operator capacity and airline routes. The two piecewise time trend components are also highly significant ($p < 0.001$), indicating that the underlying trend growth rate of arrivals shifted over the sample period — a finding consistent with the structural acceleration of Greek tourism observed from the mid-1990s onwards and the subsequent disruptions of the post-2010 fiscal crisis and the COVID-19 pandemic.

Nonlinear Effect of Forest Fires

The central contribution of the level's specification is the identification of a nonlinear relationship between fire frequency and tourist arrivals. Both F (coefficient = −9,089, t = −1.739, p = 0.091) and F^2 (coefficient = 2.451, t = 1.720, p = 0.095) are marginally significant at the ten per cent level. The negative sign on the linear term and positive sign on the quadratic term imply that the deterrent effect of fires on tourism is strongest at moderate fire frequencies and diminishes at higher levels of fire activity, suggesting a degree of tourist desensitization once fires become sufficiently frequent.

The implied turning point, calculated as $-(-9{,}089) / (2 \times 2.451) \approx 1{,}854$ fires, lies above the sample mean of 1,371 but within the observed range of the data, confirming that the nonlinearity is empirically relevant rather than an extrapolation beyond the sample. These results suggest that the marginal reputational damage inflicted on Greek tourism by an additional fire event is greater when fire activity is below approximately 1,854 incidents per year, and diminishes thereafter — a finding with direct implications for the threshold at which fire prevention investment yields the highest tourism protection returns.

Income and relative Prices

Per capita income of the origin countries (Y^w) is positive and statistically significant at the five per cent level (t = 2.367, p = 0.024), consistent with the log-log finding that Greek tourism is strongly income-driven. The relative price ratio (P^w/P^g) is also significant at the five per cent level (t = 2.038, p = 0.049), with a positive coefficient indicating that when prices in origin countries rise relative to Greece, arrivals increase — the expected competitiveness effect. Notably, while the price

variable was not robustly significant in the preferred log-log specification under HAC standard errors, it achieves significance in the levels model, which may reflect the fact that the dynamic structure — by controlling for persistence through the lagged dependent variables — reduces residual autocorrelation and improves the precision of the price coefficient estimate.

Table 4. *Dynamic Model of International Tourism Arrivals to Greece in Levels, 1980–2024*

Dependent variable: ITA. Method: OLS with HAC standard errors (Bartlett kernel, Newey-West fixed bandwidth = 4). Observations: 43 after adjustments.

Variable	Coefficient	t-Statistic
Constant	481,367	0.074
ITA(−1)	0.961	6.101***
ITA(−2)	−0.496	−6.142***
T1	444,579	4.243***
T2	405,258	6.121***
F	−9,089	−1.739*
F^2	2.451	1.720*
Y^w	4,449	2.367**
P^w/P^g	2,016,087	2.038**

R-squared	0.927
Adjusted R-squared	0.910
S.E. of regression	2,726,673
Akaike info crit.	32.657
Durbin-Watson stat	1.953
Wald F-statistic	164.517 [0.000]

Notes: ITA = international tourist arrivals to Greece; F = number of forest fires; F^2 = squared number of forest fires; Y^w = average per capita GDP of the United States, United Kingdom, Germany and France (constant 2015 USD); P^w/P^g = ratio of average CPI of origin countries to Greek CPI; T1 and T2 are piecewise linear time trends. ITA is stationary in levels as confirmed by unit root testing. The turning point implied by the quadratic fire terms is approximately 1,854 fires [= 9,089 / (2 × 2.451)], above the sample mean of 1,371 but within the observed range. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Comparison with the log-log specification

The levels and log-log specifications yield broadly consistent conclusions regarding the direction and significance of the main determinants of Greek tourism demand, but they differ in important respects that make them complementary rather than competing models. The log-log model achieves a higher adjusted R^2 (0.937 versus 0.910) with a more parsimonious specification — six parameters versus nine

— and produces coefficient estimates that are directly interpretable as elasticities, facilitating comparison with the existing tourism demand literature. The constant income elasticity of 3.4 and fire elasticity of −0.228 are clean, theoretically grounded estimates that characterize the average proportional sensitivity of arrivals to each determinant over the full sample period.

The levels model, by contrast, sacrifices parsimony and direct comparability in exchange for two additional insights. First, the inclusion of lagged dependent variables explicitly models the dynamic adjustment process in tourism demand, capturing the persistence and habit formation that the static log-log specification abstracts from. Second, and most importantly for the contribution of this paper, the quadratic fire terms in the levels model allow the elasticity of arrivals with respect to fire frequency to vary with the level of fire activity — precisely the restriction that the log-log model imposes and cannot test internally. The marginal significance of F^2 in the levels model provides suggestive evidence that this restriction may be binding at high fire frequencies, while the failure of the analogous test in log space — where $[LOG(F)]^2$ was not significant — indicates that the nonlinearity, if present, operates through the level rather than the proportional scale of fire activity.

On balance, the log-log specification is retained as the primary model for the reasons of parsimony, fit, and interpretability outlined above. The levels model is presented as a complementary specification that corroborates the core findings and additionally provides evidence of a nonlinear fire effect with an empirically meaningful turning point. Together, the two specifications paint a consistent and mutually reinforcing picture of the determinants of international tourism demand in Greece, with fire frequency emerging as a statistically and economically significant deterrent whose marginal impact on arrivals is greatest when fire activity is moderate and diminishes — though does not disappear — at the extreme fire counts observed in catastrophic years such as 2007.

Additional Variables and Specifications

Although the number of forest fires has a statistically significant negative effect on tourist arrivals, the total area burned does not appear to influence demand. This apparent paradox can be explained by differences between perceived and actual risk. Tourist decisions are typically made in advance and are strongly shaped by media coverage and destination image.

Each fire event generates separate news exposure and social media attention, regardless of its eventual size, making fire frequency a more accurate proxy for reputational damage than hectares burned.

In addition, the largest fires in Greece have historically occurred in mainland regions such as the Peloponnese and Evia, while major tourist destinations—Crete, the Aegean islands and the Ionian islands—have been less affected. This geographic mismatch weakens the link between burned area and aggregate arrivals. Statistically, the burned-area variable is highly skewed due to rare catastrophic seasons (e.g. 2007), inflating standard errors and reducing precision.

Additional dummy variables (recession years, election years, the 2004 Olympics, and the pre-euro exchange rate) were tested but proved insignificant. Their effects

were either captured more accurately by continuous variables (income and relative prices) or offset by countervailing forces, and their inclusion did not alter the main results.

Policy Implications and Recommendations

The empirical findings carry several implications for tourism and environmental policy in Greece and, more broadly, for tourism-dependent Mediterranean economies.

The Income Effect

The income elasticity of approximately 3.4 is the single most policy-relevant finding. Its magnitude indicates that Greek tourism revenues are highly sensitive to business cycle fluctuations in the main origin markets: a one per cent decline in foreign per capita income due to a recession reduces arrivals by more than three per cent. This structural vulnerability calls for two complementary strategies.

First, market diversification toward high-income emerging markets—China, the Gulf states, and India—whose growth cycles are less correlated with the European business cycle. Second, a deliberate shift toward the premium segment of the international tourism market.

These policies are currently being implemented by Greek tourism authorities, including the introduction of new direct flights to China and India, a revised visa approach with Turkiye, and strengthened geopolitical collaboration with Israel, all of which have increased tourism flows from these markets.

Environmental Protection as Tourism Infrastructure

The statistically significant fire elasticity of −0.228 establishes a direct quantitative link between environmental degradation and tourism revenue loss. Fire prevention expenditure — on early detection systems, firebreaks and land-use management in tourism-intensive areas — should therefore be budgeted and evaluated as tourism infrastructure rather than purely as ecological expenditure.

The finding that fire frequency, rather than area burned, drives visitor deterrence implies that the prevention of ignitions yields a higher tourism protection return than investment in large-fire suppression alone. Proactive destination image communication following fire events can further mitigate the reputational damage that the results suggest persists beyond the immediate incident.

Crisis Preparedness

The COVID-19 coefficient — implying a 57% reduction in arrivals— underscores the vulnerability of tourism-dependent economies to large-scale external shocks. A robust crisis management framework should include pre-negotiated liquidity support for tourism enterprises, flexible short-time work schemes calibrated to the seasonal labor structure, and contingency plans for rapid route reactivation when

demand recovers. Longer-term economic diversification would reduce the macroeconomic cost of future shocks. The EU recovery plan was an effective instrument for mitigating the impact of COVID-19, as discussed by Papanikos (2021).

Price Competitiveness within the Eurozone

The negative euro dummy coefficient reflects the loss of exchange rate flexibility following monetary union. Since internal devaluation is the only available competitiveness mechanism within the eurozone, policy should focus on containing costs in the tourism supply chain — labor, energy, port fees and VAT on accommodation and food services — relative to non-eurozone competitors such as Turkey, Egypt and Morocco. Structural reforms that improve supply chain efficiency and reduce bureaucratic costs for tourism investment can partially substitute for the exchange rate adjustment that euro membership forecloses.

Integrated Tourism Governance

The determinants identified in this study — foreign income, environmental quality, currency regime and crisis management — span the responsibilities of multiple ministries and public bodies. Effective tourism policy therefore requires cross-ministerial coordination mechanisms and the regular production of updated demand elasticity estimates to inform promotional and investment decisions.

Conclusions

This paper has estimated the determinants of international tourist arrivals to Greece over 1980–2024, embedding the novel variable of forest fire frequency within a comprehensive demand framework. Two complementary specifications — a parsimonious log-log model and a dynamic levels model with quadratic fire terms — yield a consistent picture of the forces shaping Greek tourism demand over four and a half decades.

Principal Findings

The log-log model (adjusted $R^2 = 0.937$) identifies four robust determinants. Foreign per capita income dominates, with an elasticity of approximately 3.4, confirming Greek tourism as a luxury good. Forest fires exert a significant deterrent effect (elasticity ≈ -0.23), with fire frequency — rather than area burned — the empirically relevant variable, consistent with the view that media coverage of fire events, rather than ecological damage per se, drives booking decisions.

The COVID-19 pandemic caused a 57% reduction in arrivals during 2020–2021, the largest single shock in the sample. Euro adoption is associated with an 18% reduction in arrivals, reflecting the erosion of price competitiveness following monetary union.

The dynamic levels model corroborates these findings and additionally identifies a nonlinear fire effect: the deterrent impact is strongest at moderate fire frequencies and diminishes beyond a turning point of approximately 1,854 fires per year — above the sample mean but within the observed range.

Limitations and Future Research

Several avenues for future research arise from the limitations of the present study. First, the use of a simple average of four origin-country income and price variables is a pragmatic approximation; a weighted demand model disaggregated by country of origin could reveal heterogeneity in income elasticities and fire sensitivity across markets. This approach would also allow testing for variation in income elasticities by country of origin.

Second, the annual frequency of the data prevents precise identification of the lag between fire events, media coverage, and booking decisions; a monthly or quarterly analysis, if data were available, would provide a clearer dynamic picture.

Third, the nonlinearity finding is based on marginally significant coefficients and should therefore be treated as suggestive; a cross-country panel of Mediterranean destinations could offer a more robust test.

Fourth, regional disaggregation within Greece could show whether the islands— which account for the majority of arrivals—respond differently to fire events than mainland destinations. These opportunities have been limited by data availability; however, the Bank of Greece has recently begun reporting regional data. Given that fires inherently affect specific regions, such data could enable more precise modeling of local impacts.

Concluding Remarks

To the author's knowledge, this is the first study to include forest fire frequency as a determinant in a national tourism demand model, and the first to test explicitly for nonlinearity in that relationship. As climate change increases the frequency and severity of wildfire events across the Mediterranean, the economic cost to tourism-dependent economies is likely to grow. Quantifying this cost is a necessary first step toward designing the policy responses — in fire prevention, destination marketing and crisis management — that will be required to protect the sector in the decades ahead.

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Public Policy and Regional Tourism Development: Evidence from the Pueblos Mágicos Program in Michoacán, Mexico

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Cultural tourism has become one of the leading economic activities, not only in Michoacán but throughout the world, making it essential to conduct an analysis of this topic. Mexico's public policies have recognized that the promotion of cultural heritage can be key to the development of local economies, leading to the creation of Programs such as the "Pueblos Mágicos" initiative. This research focuses on the perceptions that residents of these Pueblos in the state of Michoacán have regarding the changes this government initiative has brought about in their economy and quality of life. Through the application of both qualitative and quantitative methodologies, it was observed that although there are discrepancies among the responses, the overall perception of this public policy is positive.

Keywords: *heritage preservation, public policies, cultural tourism, Programa Pueblos Mágicos, Michoacán.*

Introduction

Cultural tourism, related to historic heritage, is a basic activity for the development of cities and locations recognized as World Heritage Sites by UNESCO. Recently, cultural heritage has taken on a role as a socioeconomic revitalizer and promoter of local development, doing so by its exploitation as a new format of tourism: Cultural tourism. In Mexico, cultural tourism has been exponentially put into practice in the last few decades, becoming a priority for the Mexican Government. In 2001, Mexico, through its Department of Tourism (SECTUR), established the public policy called *Programa Pueblos Mágicos* (PPM), designed to identify Pueblos with unique cultural and physical features that represented the everyday life of each local community. Drawing from this, SECTUR sought to bring both Mexican and international tourists to these sites, reinforcing their touristic visibility and thus improving their economy by promoting local craftworks, gastronomy and trade; in turn, this would help to gather resources to rehabilitate and preserve the Pueblos' representative appearance.

While this policy entailed attractive intentions for the comprehensive development of some least favored communities, it has resulted in significative alterations of Pueblos deemed as "Mágicos": transformation of economic activities, privileging touristic aspects over sound living conditions for locals, continuous

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migration, and the physical transformation of the very features that earned Pueblos such distinction. 25 years into its creation, the Program has registered 177 Pueblos, 10 of which are located in the State of Michoacán.

This research focuses on two main objectives: First, to analyze the consequences of public policies, such as the *Programa Pueblos Mágicos*, on tourism-based regional economy through the inhabitants' perception. And second, to analyze the economic activities of the selected Pueblos registered by said Program. The methodology is based on data collection from sources such as the Mexican National Statistics, Geography and Information Technology Institute (INEGI), economic census, the touristic observatory for *Pueblos Mágicos* and the Department of Tourism, and confront such data with the information obtained by the fieldwork conducted with the inhabitants of the 10 *Pueblos Mágicos* located in Michoacán: Angangueo, Cotija, Cuitzeo, Jiquilpan, Paracho, Pátzcuaro, Santa Clara del Cobre, Tacámbaro, Tlalpujahua and Tzintzuntzan. Finally, we will cross-check the information to identify the current context of touristic activity and local economy and thereby diagnose the future of cultural tourism in Michoacán by identifying right decisions and areas of improvement.

Literature Review

One of the elements that defines past and present societies is their memory, which is passed down from generation to generation and provides them with identity and a sense of belonging. Collective memory forms part of heritage, whether tangible or intangible, and, as a social construct, as Sigaut notes, "Heritage is a social construct" (Sigaut, 2007) and is therefore part of their culture. Following this line of thought, she proposes the need to reexamine this concept of cultural heritage, which is traditionally presented as something untouchable, separated from the reality in which it is immersed, and therefore isolated from the very society that originally gave it value.

Therefore, Muñoz asserts that "cultural heritage is that which is of interest to a social collective because it is embedded in its sociocultural dynamics, as it shapes its memory and identity, concepts that are intimately related" (Muñoz Aréyzaga 2018). Therefore, this symbiotic relationship must be rethought and redefined today, especially since it has in many cases been reduced to a mere consumer product for tourism.

Cultural tourism has been a major driver of the economy in many countries over the past few decades, as every society possesses a cultural heritage that can appeal to visitors. It can vary in that it may be intangible (such as traditions, festivals, rituals, etc.) or tangible (such as architecture, cultural routes, paintings, sculptures, etc.), but together, they provide an experience that postmodern society increasingly values. Newer generations prefer to travel and experience other cultures rather than invest in buying homes or material goods—or even starting a family trend evident in the declining birth rates observed in many nations.

On this topic, Alvarado notes that "Tourism has become a predominant economic activity in postmodern society and can be defined as a subjective construction of imaginaries related to societal ideals of happiness, a return to nature, and everyday life.

In this social and collective construction of the tourist imagination, beliefs, forms, and images surrounding a place are significant; these are (re)constructed through the experience of travel, advertising, and the narratives the visitor receives before and during their stay, but also through contact with the daily lives of the local residents." (Alvarado Rosas 2019)

These representations of "otherness" have become consumer products and, as such, factors that have shaped national, regional, and local economies. However, this activity has not always led to improved economic development and, consequently, a better quality of life for residents; in many cases—such as in cities like Seville, Venice, Paris, etc.—authorities have had to control or even reject the excess of tourism that overwhelms their neighborhoods. In this regard, Ávila considers it essential that this activity always be placed at the service of local communities. "Cultural heritage constitutes one of the basic resources for shaping a tourist destination, which must be valued and transformed into a product serving sustainable local development" (Ávila Aldapa 2014).

In this regard, governments have developed public policies aimed at addressing all aspects of cultural tourism, primarily from an economic perspective. Merino defines public policies as "a deliberate intervention by the state to correct or modify a social or economic situation that has been recognized as a public problem" (Merino 2013). Regarding the topic addressed here, it is undeniable that tourism has become a priority issue for the government, not only because it affects local economies (positively or negatively) but also because it has an impact on the preservation of cultural heritage. For example, visitors from other places arrive with different cultural backgrounds and different ideas, which often have an adverse effect on the identity of traditional communities. The intention to expand services for these tourists without taking local identity into account—such as by introducing international commercial chains like Starbucks—is also often viewed negatively, as it ultimately has a negative impact on the local economy.

These government instruments have undergone changes over time, as societies have evolved and social issues and needs have shifted, just as the political trends of governments have changed over the years. Electoral cycles often define the priorities to be addressed through social policies, as Merino notes: "Public policies are part of their historical context, their institutional environment, and the social networks in which they are embedded" (Merino 2013). This is evident in the evolution of the PPM since its creation in 2001, which will be discussed later.

A fundamental part of this element of governance is the accompanying legislation, as May notes: "Policies can take various forms, including laws, decrees, regulations, and other government actions" (May 2018). In the case of cultural tourism in Mexico, the applicable legislation falls under the purview of the Ministry of Tourism, at both the federal and state levels, where regulations have been established primarily for the operation of the *Programa Pueblos Mágicos*, and which have been amended mainly due to the increase in the number of Pueblos enrolled in this public policy.

The concept of perception in this research is based on Vargas's definition: "It is understood as the form of behavior that encompasses the process of selection and symbolic elaboration of sensory experience, bounded by human biological capacities and the development of man's innate capacity for the production of symbols" (Vargas

1994)

On the other hand, the construction of identity as a relationship with a physical and cultural environment depends largely on society and its process of constructing meaning based on the experiences these places offer their inhabitants, which then become commodities for tourism. According to (Enriquez Acosta J.A., 2019), "The attitudes and perceptions of the population living in tourist destinations are important for understanding the impact that tourism development has on economic, sociocultural, and environmental aspects."

For his part, (Arias 2006) views "perception as the result of stimulus-receiver interaction, where the subject processes information from the environment in which they operate." According to Arias (2006), social perception is shaped by the situation in which it occurs; that is, the context and the receiver's objectives influence how that perception is formed (Arias 2006).

The Program known as Pueblos Mágicos (PPM) was launched by the Federal Ministry of Tourism in 2001 as a result of the Mexican government's economic policies. The Program's objectives are far-reaching; among other things, they aim to highlight the tourism value of Pueblos with fewer than twenty thousand inhabitants in the country's interior, in order to develop an innovative and original tourism offering that meets a growing demand for culture, traditions, adventure, and extreme sports in natural settings, or the simple yet unique daily life of rural communities.

The PPM aims to promote cultural tourism, with the goal of highlighting specific destinations and boosting local development. Through this Program, the Ministry of Tourism promotes small settlements that, since time immemorial, have been distinguished by one or more unique characteristics, defined by a magical aura—whether stemming from the landscape, nature, history, legends, traditions, anecdotes, events, or real or fictional characters. Its Mágicos, so to speak, extends to the local level, the region, and, in some cases, the national sphere, to the extent that it is recognized in the collective imagination (López Levi 2015).

The Program dates back to 2001, when the Mexican Government's Ministry of Tourism, as part of the 2001–2006 National Tourism Program titled "Tourism: The Force That Unites Us," recognized the need to develop a complementary and diversified tourism offering in the country's interior, in accordance with the provisions of Chapter 5, Section 5.3: "The promotion of the country's tourism offerings is a priority for sectoral development. The growth, diversification, differentiation, and regionalization of destinations, products, and services require strategic actions that primarily focus on stimulating catalyst projects, general investment, and tourism financing in all its forms" (Secretaría de Turismo 2020) it was decided to create a public policy that supports the development of local economies, primarily in Pueblos with fewer than 20,000 inhabitants that have the potential to attract both cultural and nature-based tourism, thereby generating social and economic development for the benefit of those communities. This Program aligns with the National Tourism Policy, which seeks to promote Mexico as a global tourism destination by highlighting the country's tangible and intangible cultural heritage (Cámara de Diputados LXIII Legislatura 2017).

The report presented by SECTUR in 2006, which outlined the operating rules of the PPM (which at that time included 32 Pueblos Mágicos), lists the eligibility criteria in effect at that time, which are:

1. Involvement of the Community and Local Authorities.
1.1 Commitment to the local community.
1.2 Commitment from state and municipal authorities.
2. Planning and Regulatory Instruments.
2.1 State and Municipal Development Plans.
2.2 Municipal tourism development Program.
2.3 Urban image regulations and management plan in accordance with the Programa Pueblos Mágicos.
2.4 Program for the reorganization of semi-permanent and/or street vendors.
3. Promotion of Municipal Development.
3.1 Various Programs to support municipal development.
3.2 Continuation and consolidation of tourism development Programs and/or initiatives.
4. Attractions and Services.
4.1 Having a symbolic tourist attraction.
4.2 Having distinctive tourist attractions.
4.3 Tourist services that ensure their commercial potential.
4.4 Assistance and security services.
5. Unique Value: "The Mágicos of the Town."
5.1 Developing a thesis on the Mágicos of the town.
5.2 Designation as a "Historic Monuments Zone."
5.3 Actions to preserve tangible and intangible heritage.
6. Conditions and Territorial Spaces.
6.1 Land accessibility.
6.2 Feasibility for tourism marketing.
6.3 Tourism product.
7. Impact of Tourism on the Locality and Area of Influence.
7.1 State tourism information system.
7.2 Assessment of tourism impact at the regional and/or municipal level.
8. Local Capacity Building
8.1 Programa Pueblos Mágicos induction workshop.
8.2 Workshop on cultural tourism planning and management.

As can be seen, the first and most important point is the involvement of society and local authorities; that is, the role of social participation within the different stages of implementing the PPM is considered fundamental according to these operating rules. However, the studies and research cited above show the exact opposite in many cases, significantly limiting social participation (Secretaría de Turismo 2006).

In 2013, nominations for Pueblos Mágicos were suspended while a comprehensive evaluation of the Program's actual performance was conducted, analyzing each of the 111 Pueblos Mágicos that existed at the time. SEGOB stated the following in an agreement that year: "Thirteen years after the establishment of the Programa Pueblos Mágicos, it was necessary to conduct an assessment to identify the progress, problems, and opportunities arising from its operation, in order to seek new alternatives for its restructuring and consolidation as a comprehensive, effective program independent of others also operated by the Ministry of Tourism, in such a way as to reduce the significant disparities that currently exist among the localities, as

well as to establish adequate monitoring of actions and control through indicators that allow for the accurate assessment of their economic impact" (Secretaría de Gobernación. (26 de 09 de 2014).

These new operating rules, resulting from the aforementioned restructuring, emphasized two broad categories: sustainability and competitiveness as the guiding principles of the PPM. As shown below, the requirements for joining the Program remained consistent with those of the original PPM in 2001.

I. Formal establishment of a Pueblo Mágico Committee;
II. Approval by the municipal council of the town's application to join the Programa Pueblos Mágicos;
III. Approval and resolution by the State Legislature establishing the budgetary resources to be allocated to the applicant locality;
IV. Budgetary resources allocated or to be allocated for tourism development in the applicant locality;
V. Government Programa and actions that have an impact on tourism development in the applicant locality, with a minimum projection of 3 years;
VI. Current municipal regulations with an impact on tourism development;
VII. Evidence of the symbolic appeal of the applicant locality;
VIII. Description of public health and safety services to assist tourists in the event of an emergency;
IX. Private and social investment for tourism development in the applicant locality; and
X. Any other aspects deemed relevant to tourism by the Secretariat.

In these ten points, it is clear that there is no mention of the importance of social participation (residents and local authorities) in various aspects such as decision-making and involvement in the development and implementation of the PPM, unlike the 2006 version, which did include it—and in a prominent position, at that.

In 2018, with the arrival of a new political group in the Mexican government, the end of the PPM was announced, in the sense that the financial support component would be discontinued. Thus, starting in 2019, funding was no longer provided to the municipalities participating in the Program, and it was consequently removed from the Federal Expenditure Budget (Tolentino Morales 2023). Subsequently, in 2020, the National Strategy for Pueblos Mágicos was published (Secretaría de Turismo 2020) in which it can be seen that several eligibility criteria have changed and are now as follows:

a) An updated inventory of tourism resources and attractions, accompanied by a photographic report, based on Form B of Annex 1 of the National Strategy.
b) An updated directory of tourism service providers, based on Form C of Annex 1 of the National Strategy.
c) A Municipal Tourism Program aligned with the National Development Program, PROSECTUR, the National Strategy, as well as sectoral and/or institutional plans and Programs at the state level. To this end, this Program shall include, at a minimum, the following sections:

1. Assessment of socioeconomic conditions and tourism in the municipality.
2. Sustainable tourism, with a special focus on the conservation and restoration of cultural heritage.
3. Inclusive tourism with a social perspective.
4. Management and allocation of budgetary resources focused on the maintenance and development of urban infrastructure related to tourism.
5. Registration of information in the National Tourism Registry.
6. Data entry into DATATUR.
7. Quality standards and tourism certification.
8. Training and professional development of tourism service providers.
9. Development of the Ethnographic Classroom.
10. Tourism promotion of the locality.
11. Private sector participation.
12. Integration of value chains.
13. Comprehensive safety and security for tourists.
14. Health and environmental safety.
15. Section on indicators and targets.

d) Cartographic information on the geographical boundaries of the tourist area to be designated as a Pueblo Mágico, highlighting the areas where the town's symbolic appeal is most clearly expressed.
e) An official statement from the City Council declaring the following commitments regarding the tourist area:
    1. To grant building permits only to structures that harmonize with the local architecture, in accordance with applicable regulations.
    2. To implement programs for the improvement and conservation of urban infrastructure.
    3. Implement a program to reorganize semi-permanent and/or street vending.
f) A letter of commitment from the State regarding the allocation of budgetary resources and the management and implementation of actions aimed at the well-being and sustainable tourism development of the applicant locality.

As is evident, none of the above points mention the social participation of the community and local authorities, which, like the 2013–2014 version, leaves out this fundamental aspect—one that should continue to serve as the foundation upon which the entire PPM is based.

However, PROSECTUR 2020–2024 makes no mention of social participation in any of its four priority objectives (Priority Objective 1: Ensure a social approach and respect for human rights in the country's tourism sector; Priority Objective 2: Promote the balanced development of Mexico's tourist destinations; Priority Objective 3: Strengthen the diversification of tourism markets at the national and international levels; and Priority Objective 4: Promote sustainable tourism within the national territory) mentions social participation that would support economic development, which confirms this tendency to ignore local communities, which, after all, are the custodians of that natural and/or cultural heritage (Secretaría de

Turismo 2020).

The collaborative project led by Liliana López Levi and Carmen Valverde, titled "Pueblos Mágicos: An Interdisciplinary Perspective," brings together specialists from across Mexico in various fields of study (architects, urban planners, anthropologists, etc.). The goal was to analyze all the Pueblos Mágicos from a variety of perspectives. This collaborative effort resulted in a five-volume collection comprising 20 chapters each one, each focusing on a different Pueblo Mágico and offering a unique perspective. This work has served as a benchmark for all scholars of the subject, addressing diverse topics such as identity, commerce, artisanal production, sustainable tourism, natural heritage conservation, collective imaginaries, the influence of marketing, the quantity and quality of tourism services, demographic shifts, environmental risks, the preservation of traditions, the influence (negative and/or positive) of local governments, the impact on infrastructure, paradigm shifts, and foreign influence, among many others.

Among the major studies that have focused on the local economies of the Pueblos Mágicos, we can mention some of those presented in this collective project, such as López Levi's study on Valle de Bravo—which was designated a Pueblo Mágico in March 2005—in which he analyzes the relationship between tourism and real estate development (López Levi, L. (2015). Another notable study is the case of Amealco de Bonfil (González Gómez 2019), in which the authors correlate five elements to analyze the economic situation of this town: the town's origins, its geographic identity, economic backwardness, the inertia of the PPM, and government support.

Another recent study is the one conducted by Arellano, Rojas, and Larios on Xicotepec, in which they analyze how to determine strategies for economic and sustainable development in this Pueblo Mágico based on a study of the local issues that influence the local economy (Arellano Solís 2022).

Finally, another 2025 study by Covarrubias, Vera, and Ascencio (2025) analyzes tourism in the Pueblos Mágicos from the perspective of economic activity development and as a source of job creation.

Methodology/Materials and Methods

To measure the impact of tourism on the local population in Michoacán's Pueblos Mágicos, a direct method was used that relies on information provided by the local population, service providers, and tourists, focusing on the social perception of the economy. To achieve this objective, the necessary instruments were designed to obtain quantitative and qualitative data on residents' perceptions of how the implementation of this public policy has impacted their local economy.

The methodology chosen to determine how residents assess the economic, social, and cultural impact of the program involves the use of standardized questionnaires and open-ended interviews (Hernández Sampieri 2008), the latter of which were recorded and subsequently transcribed. The questionnaires consisted of 20 items, ranging from basic information such as place of origin, length of residence in the locality, age, gender, and type of work; the second part covers questions about their understanding of what this public policy entails, such as whether they are

familiar with the program's regulations, how both local and federal governments handle decisions that affect them, what their rights and obligations are as residents of a Pueblo Mágico, who their representatives are before the authorities, among others; finally, the third section contains specific questions about their perceptions, such as whether they have noticed changes in the unemployment rate, whether the number of tourism services has increased, whether they have noticed improvements in the local economy, whether their economic activity has improved since their town was enrolled in the program, and whether their quality of life has improved.

From August through December 2025, questionnaires were administered to key stakeholders (residents, tourists, merchants, and authorities); however, this document refers only to the residents of Michoacán's "Pueblos Mágicos," as defined by the date they were designated as part of the PPM: Pátzcuaro in 2002; Tlalpujahua in 2005, Cuitzeo in 2006, Santa Clara del Cobre in 2010, Tzintzuntzan, Jiquilpan, Tacámbaro, and Angangueo in 2012, Paracho in 2020, and Cotija in 2023. Using the following formula, the sample size of 272 questionnaires was calculated based on the number of inhabitants, with a 5% margin of error and a 90% confidence level.

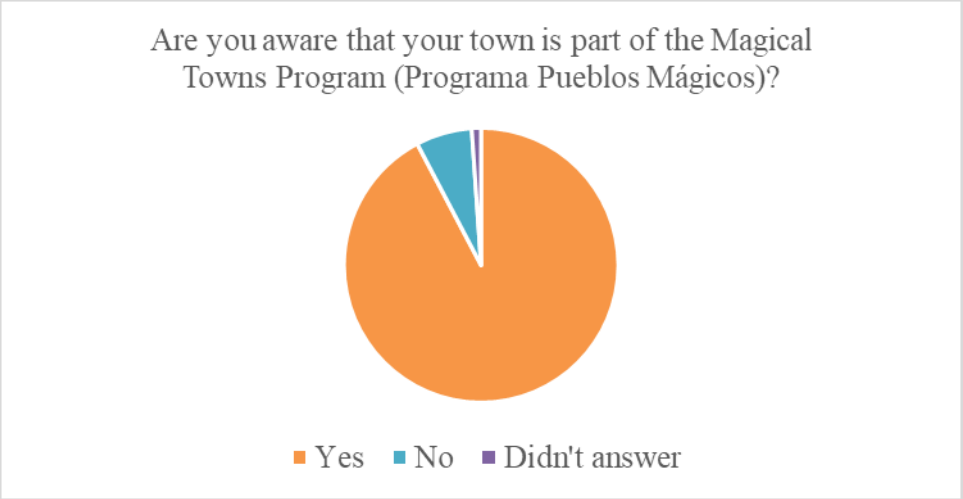
$$\frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

The results were cross-referenced with information gathered from government data sources, literature on the PPM, news articles, and official Mexican government websites.

Results and Discussion

Using the information gathered, the data obtained were analyzed within the theoretical and methodological framework, yielding the following results.

Figure 1. *Perception about being part of the PPM*



When asked about their awareness of the Program's membership (Figure 1), it was found that the vast majority of the population was aware of it, but a few were unaware of this situation, even though it is obvious that it should directly affect them. When comparing this information with the following question (Figure 2) regarding whether they were familiar with the rules and regulations applicable to the PPM—such as the National Strategy for Pueblos Mágicos document published in 2020 and currently in effect—nearly half stated they were unaware of them, which can be interpreted as a lack of interest on the part of the population in understanding how this public policy directly affects them.

One of the biggest problems affecting the Mexican population in general is their lack of interest in participating in and learning about the public policies that affect their quality of life, economy, and even the social, political, and cultural contexts in which they live their daily lives, thereby ignoring the reality they face. This was evident in the responses to the question about their knowledge of how both local and federal governments handle decisions that affect them (Figure 3), as several respondents had never seen the government reports issued by their authorities each year or during each election cycle, or, if they had heard of them, they had never analyzed them.

Figure 2. *Knowledge of PPM Regulations*

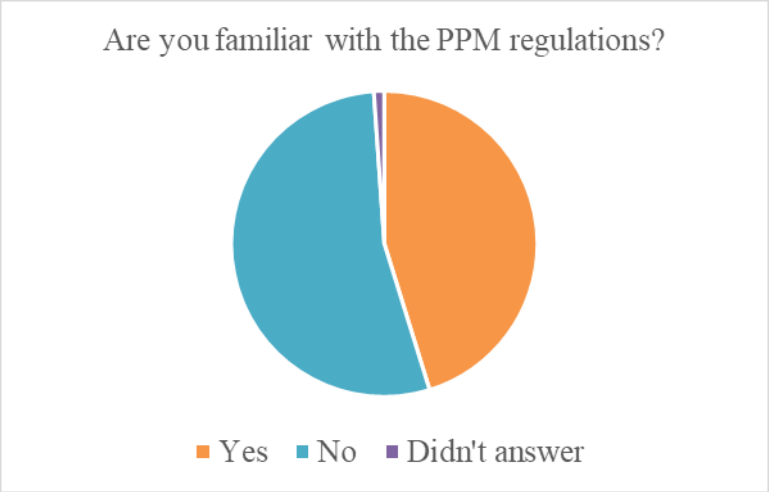
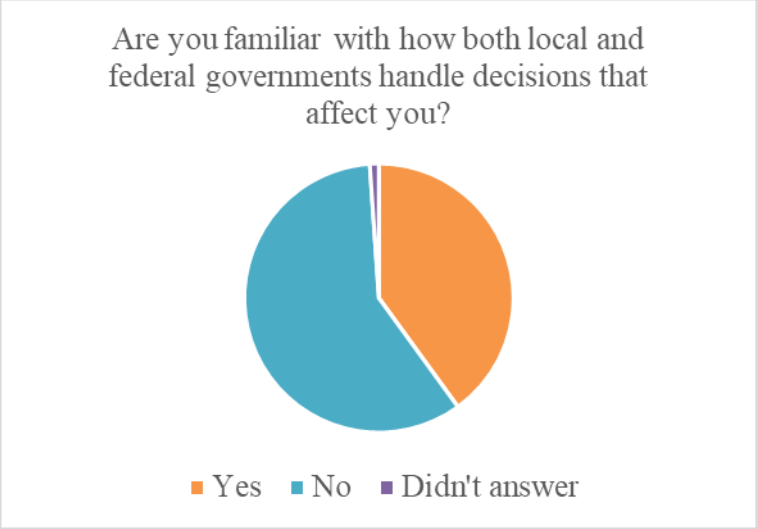


Figure 3. *Regarding Knowledge of how both Local and Federal Governments Handle Decisions*



When considered alongside this question and the next one (Figure 4), the lack of awareness and apathy surrounding this program becomes clear, as a high percentage of the population is unaware of their rights and obligations, resulting in virtually no active participation in anything related to the PPM—which ultimately affects their way of life.

In the following section of questions on specific aspects linking perception and the economy, the Sustainable Development Goals set forth in the UN 2030 Agenda were taken into account when drafting the questions, particularly Goal 8 on decent work and economic growth. The aim of this goal is to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.[1]

[1]Data obtained from the UN website https://agenda2030.mx/ODSGoalSelected.html?ti=T&cveArb=ODS0080&goal=0&lang=es#/ind [05/04/2026]

Figure 4. *Regarding Knowledge of the Rights and Obligations as a Resident of a Pueblo Mágico*

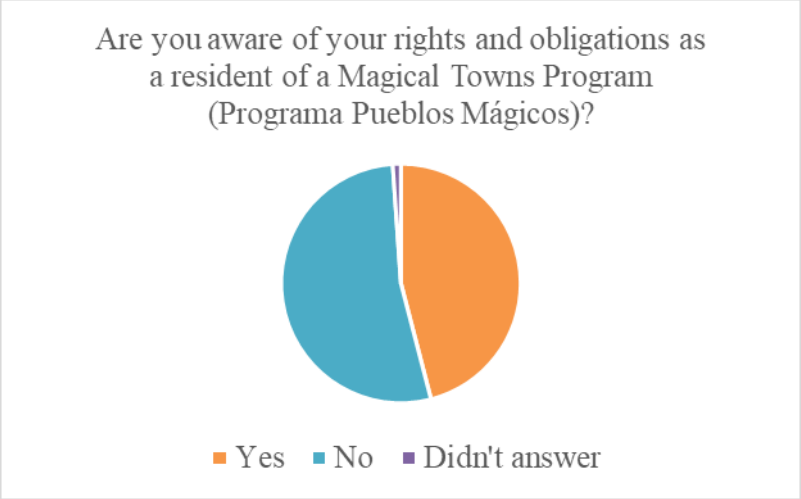
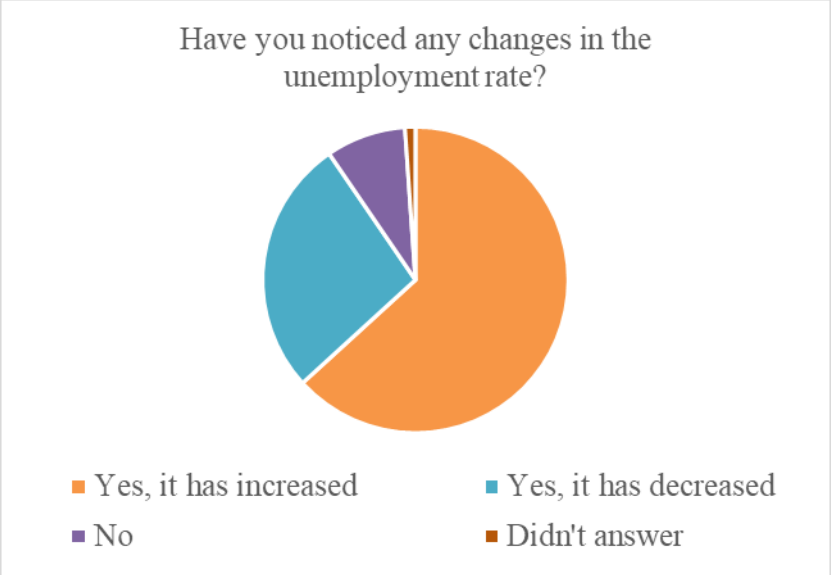


Figure 5. *Regarding the Perception of Changes in the Unemployment Rate*



According to government data available on the Data México website, the state of Michoacán has an unemployment rate of 1.17% for 2025, 1.17% for 2020, and 5.3% for 2010, indicating that, overall, unemployment has declined over the past two decades. However, 63% of the population in the surveyed Pueblos Mágicos perceives that unemployment has increased (Figure 5), mainly because there has been a significant rise in informal trade, which skews statistical data and negatively impacts established businesses.

One of the sectors most affected by informal commerce is tourism services, primarily due to the rise in tourist guides without formal training, the sale of handicrafts made in China, the sale of souvenirs not produced in the Pueblos Mágicos, and the sale of food at street stalls that do not meet minimum health standards, etc. This can be seen in the results of Figure 6, where 67% of respondents

report that established tourism services have not increased, in contrast to the number of informal businesses, which has skyrocketed in recent years.

Figure 6. *Regarding the Perception of the Increase in the Number of Tourist Services*

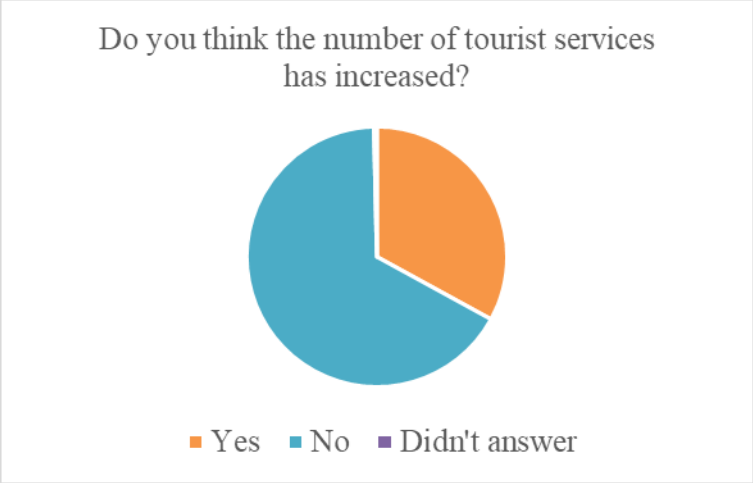
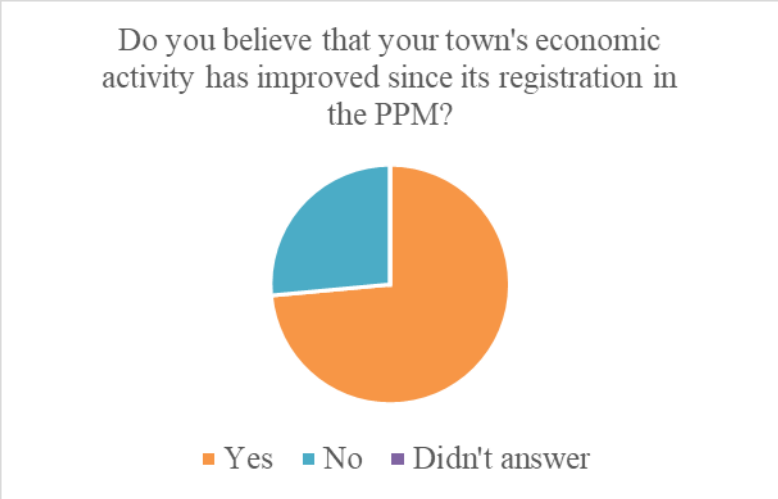
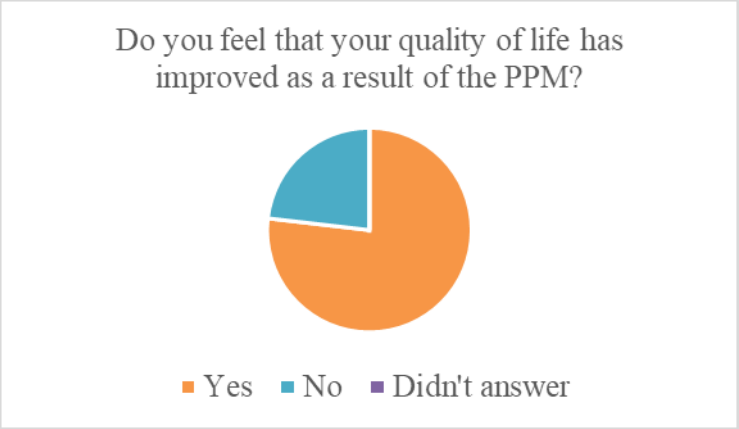


Figure 7. *Perception of Improvement in Personal Finances*



In contrast to the previous responses, the majority of the population perceives that their economic situation has improved since their town was enrolled in the PPM (Figure 7), and that the development of the local economy has generally improved. According to the responses obtained, respondents note that as visitor numbers have increased, the infrastructure of their Pueblos has improved (with the exception of Cuitzeo, where they believe it has not improved in any way). They view the increase in tourism as positive and believe that the economic benefits it brings have been beneficial for most residents.

Figure 8. *Perception of improved Quality of Life*



Together with the responses to the final question regarding whether their overall quality of life has improved (Figure 8), it is possible to see the correlation between the perception of economic improvement and improved quality of life (once again, with the exception of Cuitzeo) following their inclusion in the PPM.

Conclusions

Throughout this document, the research design process was outlined. Although this is only one component of the broader research project titled "Michoacán's Pueblos Mágicos: Development, Tourism, and Sustainability"—funded by the Universidad Michoacana de San Nicolás de Hidalgo and conducted from 2024 through 2027—it forms an integral part of that initiative. The development of the theoretical and methodological framework guided the research, enabling the design of effective tools for collecting reliable data that captured the perceptions of residents in the ten Pueblos Mágicos of Michoacán regarding public policy, its implementation, and its impact on local economies.

By cross-referencing data with information obtained from official sources, the scope was broadened, identifying disparities between the reality of the reported figures and what the people perceive in their daily lives. The creation of graphs facilitated their analysis and interpretation.

The results from the second set of questions show that a significant part of the limited effectiveness of this public policy stems from the public's lack of awareness regarding the PPM, as well as their apathy toward it, despite the fact that it has a real impact not only on their economy but also on their daily quality of life. Cultural tourism also impacts the preservation of both tangible and intangible heritage, as well as achieving the sustainability necessary for genuine development across all sectors: social, economic, environmental, and others.

Regarding the third section, the greatest difference was observed in the respondents' perceptions of the relationship between public policy and the economy. For example, they acknowledge their lack of knowledge about the PPM and their apathy toward actively participating in its implementation, yet at the same time, they perceive improvements in their economic situation and quality of life.

In conclusion, we can state that further research is needed on the challenge of establishing a symbiotic relationship between public policy, cultural tourism, and the economy. The development of better governance tools, support for local tourism businesses and stakeholder groups such as artisans and service providers, improved public education regarding the PPM as a whole, and the enhancement of legislation governing cultural tourism all pave the way for more effective solutions.

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