

Exurban Development, Rural Areas, and Landscape Conservation: Does Sustainable Tourism Tell you More?

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Abstract

Exurban development is a basic process of regional change characteristic of both urban and rural districts of advanced economies. While experiencing persistent sprawl processes, European, and especially Mediterranean, regions reflect diversified development paths often under distinctive socio-demographic conditions. In these contexts, (originally) rural areas evolved under rapid transformation because of tourism development. Such dynamics require additional research and comparative (planning) analysis aimed at supporting a comprehensive understanding of their territorial complexities and economic implications. A comparative scrutiny of key variables such as varying population sizes and settlement densities, availability of buildable land, activities' concentration, prevailing institutional characteristics, and cultural traits of local communities, will provide relevant information overcoming the knowledge gap mentioned above. A paradigmatic example of tourism-driven sprawl determining low-density settlement expansion and uneven second-home growth in rural districts of Mykonos' island, Greece, was presented here. The study has extensively benefited from the use of official statistics – mainly population censuses – and field survey. Our empirical findings clarify the intrinsic peculiarity of rural sprawl and tourism development processes in respect with other socioeconomic contexts in Southern Europe, possibly demonstrating the policy-driven appropriateness of an integrated assessment framework of rural sprawl that may consider the outcomes of this (and similar) study(-ies) at both local and regional scale.

Keywords: Residential settlements, Sustainable local development, Landscape fragmentation, Islands, Mediterranean.

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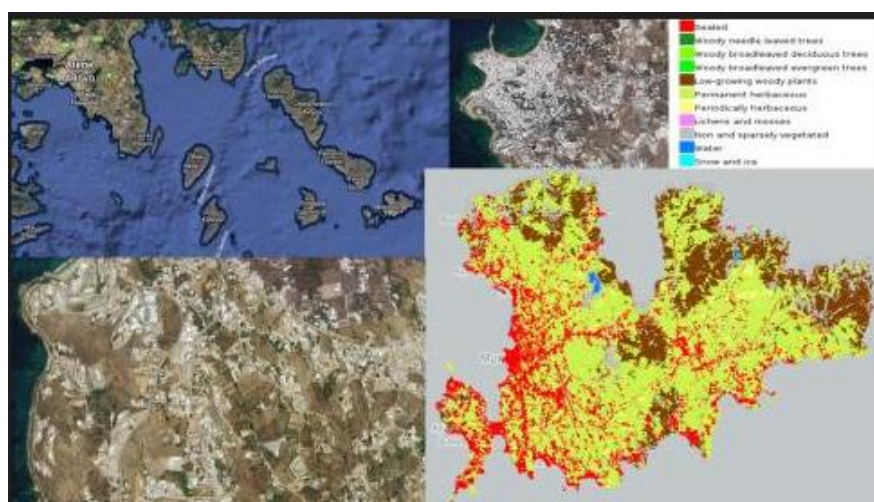
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Graphical abstract



1. Introduction

Among other relevant urbanization factors, elevation, distance from the coastline, population density, settlement structure, traditional land-use practices, and the availability of buildable land, have historically influenced settlement expansion (e.g. Alphan, 2003; Chorianopoulos *et al.*, 2010; Salvati *et al.*, 2016). While urbanization is frequently regarded as a dominant feature of recent development trajectories in advanced economies, the adverse externalities associated with metropolitan expansion — such as land consumption, habitat fragmentation, and biodiversity loss — are increasingly evident in recent times (e.g. European Environment Agency, 2006), calling into question its assumed benefits for regional development and local competitiveness (Coluzzi *et al.*, 2022).

In recent years, flat and coastal regions have experienced a marked expansion of low-density settlements across Europe (Bruegmann, 2005; Couch *et al.*, 2007; Polyzos *et al.*, 2008). This trend has been closely associated with the consolidation of metropolitan networks centered on service-based activities and the growth of tourism, especially from summer visitors (e.g. Schneider and Woodcock, 2008; Salvati, 2013; Seifollahi-Aghmiuni *et al.*, 2022). Concurrently, exurban growth has progressively extended into rural areas located beyond metropolitan regions (Sallustio *et al.*, 2018). The emergence of tourism resorts and the uneven decentralization of commercial and industrial facilities, have played a significant role in driving these ‘suburban transitions’ characteristic of the ‘Anthropocene’ era (Coccossis *et al.*, 1996; Cuadrado-Ciuraneta *et al.*, 2017; Ridolfi *et al.*, 2017).

The systematic monitoring of exurban expansion beyond established metropolitan boundaries constitutes a critical concern within regional science and applied economics (Frenkel and Ashkenazi, 2007). To address this important phenomenon, scholars have developed a suite of analytical indicators designed to quantify and characterize sprawl dynamics in predominantly rural and peri-urban

environments (Hasse and Lathrop, 2003). These indicators have been instrumental in longitudinal assessments of soil governance and land-use management, providing insight into the efficacy of policies aimed at safeguarding priority habitats, conserving natural resources, and enhancing both the aesthetic and ecological quality of landscapes (Egidi *et al.*, 2020). Yet, despite their conceptual and empirical use, the operationalization of such measures — particularly those derived from remote sensing, satellite imagery, or extensive computation of enumeration-district datasets derived from population and building censuses — remains resource-intensive, often requiring significant time, technical expertise, and financial investment (Leontidou and Marmaras, 2001).

In response to these methodological constraints, the present study proposes a streamlined, yet analytically robust, framework for examining exurban development. This approach summarizes the individual outcomes of simplified demographic indicators, selected official statistics at municipal and (local) district levels, and the interpretative analysis of landscape (or zenithal) photographic evidence (e.g. Imbrenda *et al.*, 2021). This exercise was run in the case of Mykonos, Cyclades Archipelago (Greece), which serves as a paradigmatic example of ex-urbanization in low-density territorial systems that evolve largely outside the direct functional influence of metropolitan centers (Kizos *et al.*, 2007).

Empirical analysis of the evolution of Mykonos’ settlements vis à vis the recent trends in tourism development in Cyclades’ archipelago allows for a systematic reconstruction of the sequential stages of exurban growth in a context of tourism-driven, long-term developmental path, integrating both structural and functional perspectives (e.g. Salvati and Zitti, 2008). This approach identifies the primary drivers shaping settlement expansion and elucidates the complex interplay between demographic, economic, and ecological factors (Spilanis *et al.*, 2009). Collectively, the study presents an integrated

monitoring paradigm (*sensu* Salvati and Carlucci, 2011) offering transferable insights for environmental management, spatial planning, and policy development at regional, national, and continental scales.

2. Methodology

2.1. Study area

The study focuses on Mykonos' island in Cyclades, which encompasses an area of approximately 100 km². As one of the Mediterranean's most historically significant tourism destinations, the island has undergone profound transformations over the past five decades (Stott, 1979). These changes have been largely driven by the spatial expansion of its principal settlement (Chora). Chora has functioned as the primary locus of both residential and economic activity (e.g. Stott, 1973) because of the harbor – whose activity is one of the biggest (in volume) in the insular Aegean Sea –, the closeness to famous beaches, the intrinsic connection with the international airport – few miles away –, and the unrested summer nightlife, more recently expanding all over the years and consolidating the tourism model of 'sun, leisure and nightlife' for Mykonos. Concurrently, the development of tourism infrastructure and secondary residences in peripheral areas has fostered a marked concentration of population and built environments, particularly along the coastal margin (Stott, 1996). Longitudinal demographic analyses, employing family reconstitution and inverse projection methodologies, have illuminated the long-term population dynamics of Mykonos (Hionidou 1995). During the pre-transitional period, the island's demographic regime was characterized by low mortality, limited marital formation, and mid-to-elevated fertility (Atay and Saladie, 2022). While these conditions were theoretically conducive to pronounced population growth, substantial emigration effectively mitigated natural increase, maintaining relative demographic equilibrium over time (Kavallinis and Pizam, 1994). The subsequent demographic transition was marked by a rapid and concurrent decline in both fertility and mortality (Prokopiou *et al.*, 2024). Nevertheless, across both pre-transitional and transitional stages of Mykonos' recent history, variations in fertility emerged as the principal determinant shaping population growth, rather than changes in mortality (e.g. Stott, 1979). These patterns underscore the intricate interplay between endogenous demographic processes and migratory flows in determining the historical population structure of Mykonos, highlighting the centrality of fertility dynamics in the island's demographic evolution (Hionidou, 1995).

2.2. Official statistics, elementary variables and quantitative analysis

The present work leverages an extensive compilation of data capturing resident population density, settlements, and land-use at municipal scales, sourced from official statistics (e.g. Salvati and Zitti, 2009). To facilitate a comparison across local territories characterized by diverse settlement structures, the adopted variables (and indicators) were organized and standardized across multiple spatial hierarchies and analysis' domains (*sensu*

Salvati and Zitti, 2005): (i) the island of Mykonos, (ii) the broader Cyclades' prefecture, (iii) selected administrative regions within Greece, corresponding (in most cases) to the NUTS-3 statistical delineation (Eurostat) or, less frequently, to the NUTS-2 statistical delineation, and (iv) the national level (Greece as a whole), when more appropriate. Data acquisition from the Hellenic Statistical Authority (Elstat) ensured methodological rigor, consistency, and reliability across all these spatial scales (Salvati and Carlucci, 2014). Land-use evolution was reconstructed for Mykonos and the Cyclades prefecture as a whole (*sensu* NUTS-3 Eurostat definition of Cyclades' prefectural unit) by integrating complementary sources, including the Land-Use Census provided by Elstat on behalf of the National Census of Agriculture and Livestock. We considered six primary land-use categories: cultivated land, pastures, forests, inland water bodies, urban areas (buildings), and inland water (Skagias *et al.*, 2021). For each spatial domain, the proportional representation (i.e. percent share) of each category was calculated relative to the total area (hereafter 'total landscape'), enabling a systematic and nuanced analysis of spatial heterogeneity in land allocation (Skagias *et al.*, 2023). This integrative approach provides a comprehensive framework for examining land-use transformations at multiple geographic scales (Stott, 1985).

Territorial structure and settlements were further examined through descriptive statistics encompassing population size and density, computed at the most disaggregated spatial resolution available to the general census (villages). Collectively, these indicators provide a multidimensional understanding of morphological and functional characteristics of settlements, such as density, vertical development, and morphological evolution, capturing both spatial and temporal variations (Salvati *et al.*, 2015). Finally, the spatial determinants and patterns of second-home development were assessed (e.g. Kizos *et al.*, 2009). Taken together, this empirical investigation elucidates whether newly constructed residential units preferentially clustered near smaller settlements, particularly along the coastal periphery, highlighting the intricate interplay between demographic pressures, tourism-driven residential demand, and the spatial organization of settlements (Ntalakos *et al.*, 2025).

3. Results

The demographic evolution of Greece, encompassing both densely populated urban centers (e.g. metropolitan Athens, or Thessaloniki), and a selection of coastal and insular regions, was presented in **Table 1**, focusing on the years 2014 and 2024 based on official records from the national population register (Elstat). The aggregated statistics indicate a marked population decline at the national scale, although the intensity and pace of these reductions vary substantially across different geographical contexts, with urban, coastal, and insular territories exhibiting possibly distinct demographic trajectories. This contraction represents a noteworthy deviation from the sustained expansion observed after World War II. Notably, despite their well-established orientation toward tourism, Cyclades' islands experienced the most pronounced

population decrease within the study area, with an average annual reduction of approximately 0.7%. In contrast, other insular regions, such as Crete, the Ionian Islands, the Dodecanese, or the Northern Aegean, demonstrated either

more restricted declines or, in some cases, modest population growth – reflecting their continuing prominence as well-established tourist destinations within the Eastern Mediterranean basin.

Table 1. Recent demographic dynamics (inhabitants) in selected Greek prefectures (national population register, 2014-2024)

Regional unit	2014	2024	Annual growth (%)
Greece	10,926,807	10,400,720	-0.48
Attica	3,863,763	3,784,565	-0.20
Ionian islands	207,664	200,642	-0.34
North Aegean Islands	198,581	201,007	0.12
Dodecanese Islands	207,434	209,188	0.08
Cyclades Islands	127,368	118,058	-0.73
Crete	630,889	622,491	-0.13

Table 2. Selected demographic and territorial indicators, Mykonos (1861-2021).

Year	Resident population (inhabitants)	Annual growth rate (%)	Population density (inhabitants/ km ²)
1870	4,163	-	49
1879	4,674	1.4	55
1889	4,525	-0.3	53
1896	4,403	-0.4	52
1907	4,589	0.4	54
1920	4,291	-0.5	50
1928	4,505	0.6	53
1940	4,560	0.1	54
1951	3,546	-2.0	42
1961	3,718	0.5	44
1971	3,863	0.4	45
1981	5,530	4.3	65
1991	6,170	1.2	73
2001	9,660	5.7	114
2011	10,190	0.5	120
2021	10,704	0.5	126

As a more localized point of analysis, Mykonos was examined as a case study over the period spanning 1861 to 2021 (**Table 2**), revealing a complex demographic trajectory that contrasts sharply with the aggregate trends observed for Cyclades' islands as a whole. For more than a century, until the 1960s, the island maintained a remarkable demographic stability, with population densities remaining within the narrow range of 45 to 55 inhabitants per square kilometer. In the decades that followed, however, Mykonos underwent a moderate demographic expansion, with the resident population increasing from approximately 4,000 individuals in 1971 to nearly 11,000 by 2021. However, population density remained relatively moderate, ranging between 120 and 130 inhabitants per square kilometer, indicative of a continued spatial dispersion of residents across the island.



Figure 1. Selected pictures from Google Earth Engine delineated settlement expansion in Mykonos island: (left) compact

settlements around the harbor in downtown Chora (the central city); (right) spatial dispersion of low-density (residential) settlements in between the sea coast and the airport, south of Chora; author's elaboration of 2025 images.

Until the 1970s, residential settlements in Mykonos have been characterized as a densely concentrated, compact spatial structure, with housing clusters primarily located around Chora, the main (urban) center, and the adjacent harbor, and detached buildings remaining sparse over the rest of the island. This morphology reflected the recent evolution of traditional Mediterranean settlements. In the subsequent decades, however, a significant expansion of dispersed settlements took place in both remote and central places – predominantly consisting of single-story buildings (illustrated in **Figure 1**, right side). Over the 20th century, the density of buildings increased progressively, reaching approximately 1.5 buildings per hectare by 2021 – a figure substantially higher than the Cyclades' prefectural average – thereby underscoring the intensity and extent of settlement expansion on Mykonos relative to its regional counterparts.

Selected demographic and morphological indicators, as reported in **Table 3**, further highlight the distinctive nature of Mykonos' settlement patterns. The island exhibits a particularly low ratio of compact settlements (population

living in downtown Chora). Moderate-to-high population densities were observed only in Chora. Densities in territories classified as urban and rural (*sensu* Elstat) were relatively similar, ranging between 50 inhabitants/km² and 150 inhabitants/km². These patterns collectively illustrate the predominance of dispersed, low-density residential forms on Mykonos, in stark contrast to both regional (islands) and metropolitan (mainland) settlement structures.

The surge in building activity post-1980s was concentrated predominantly in rural (fringe) areas – often situated at considerable distances from the main villages – and followed a temporal pattern distinctive from other Cyclades' islands. Correlation analysis (**Figure 2**) reinforces this interpretation, demonstrating a negative (linear) relationship signifying that smaller villages accommodate a disproportionately higher number of unoccupied or seasonal residences. Collectively, these dynamics have

mainly produced the dispersed, low-density settlement pattern that characterizes the contemporary landscape of Mykonos.

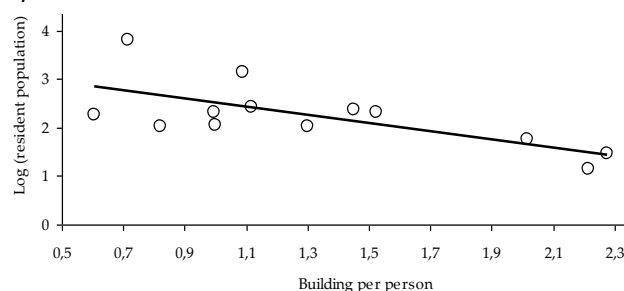


Figure 2. The relationship between the number of buildings per resident inhabitant and total population size (resident ('monimos') population) of (urban and rural) settlements in Mykonos' municipality (population-building census, 2021); Bravais-Pearson moment-product linear correlation coefficient ($r = 0.46$, $p < 0.05$, $df = 13$).

Table 3. Selected population, settlement and territorial indicators in Mykonos (census 2021).

Indicator	Inhabitants	% of total population	Population density (inhabitants/km ²)
Total municipality	10,704	100.0	101.2
Mykonos (urban areas)	8609	80.4	133.7
Chora (downtown)	4,808	44.9	479.1
Ano Merà (rural areas)	2,095	19.6	50.7

Table 4. Land-use distribution in Mykonos and Kyklades (2000).

Land class	Kyklades(K)	Mykonos(M)	M/K ratio
Arable land	10.8	28.9	1.7
Buildings	1.3	2.2	0.7
Shrublands	26.4	34.4	0.3
Open spaces with little/no vegetation	30.4	24.4	-0.2
Heterogeneous farmlands	19.6	9.5	-0.5
Inland waters	9.1	0.6	-0.9
Permanent crops	1.8	0	-1.0
Transitional woodland and shrubs	0.2	0	-1.0

Finally, long-term land-use transformations on the island were concentrated primarily in agricultural lands and pastures (**Table 4**). These characteristics collectively illustrate a fragmented and resource-limited landscape. Land-use composition of Mykonos diverged substantially from the Cyclades' average: unproductive lands - including urbanized areas - comprised 46% of the island, compared to less than 10% across the Cyclades. Artificial surfaces were definitely more extensive on Mykonos than in the other Cyclades' islands. This figure, however, was rather comparable to other large, rapidly developing islands subject to high tourism pressure, including Naxos, Paros, Syros, and Thira (Santorini).

4. Discussion

The contemporary expansion of both urban areas and more isolated buildings on Mykonos has primarily unfolded through the systematic transformation of peripheral agricultural and pasture land into residential and mixed-use zones, possibly based on tourism-led incentives and speculative housing pressures (Karatzoglou and Spilanis, 2010). The resulting landscape, assumed as relatively homogeneous, and combined with the availability of land

suitable for development, created conditions conducive to extensive coastal settlements, facilitating the outward growth of residential clusters beyond the traditional urban core (Monokrousou *et al.*, 2025). Concurrently, the simultaneous increase in permanent residents and seasonal second-home ownership exerted pronounced pressures on a landscape that is both ecologically sensitive and structurally fragmented – heightening the potential for soil degradation and broader environmental deterioration (e.g. Kavallinis and Pizam, 1994; Briassoulis, 2007; Kizos *et al.*, 2007).

Throughout the 1970s and the 1980s, these dynamics were possibly exacerbated by institutional shortcomings, including inadequate planning frameworks, and the insufficient enforcement of regulations governing land appropriation and illegal construction of second-home dwellings, mainly into isolated (or detached) buildings (Salvati *et al.*, 2013). Such regulatory gaps enabled a pattern of unplanned settlement proliferation, reflecting trends observed in other Mediterranean islands characterized by intensive tourism-driven growth (Leontidou and Marmaras, 2001). In contrast, more recent development trajectories have begun to diverge from

these historical patterns in comparison to the wider region of Cyclades, a divergence attributable to variations in settlement organization, landscape composition, and the intensity of tourism-related socioeconomic pressures (Spilanis *et al.*, 2009). These results suggest the strict peculiarity of Mykonos, and other islands as Santorini and, possibly, Paros, in respect with the ‘average’ territorial, social and economic landscape characteristic of Cyclades’ islands (Tsartas, 1992).

Spatially detailed analysis within this study identifies several focal areas of exurban development on Mykonos: the Western portion of the island, the periphery of Chora (downtown), as well as the majority of the sandy coastline, but also selected interior areas (Ano Merà) predominantly developed during the 1990s and the 2000s. This reflects a progressive de-concentration of central town (Chora) into suburban places taken as tourism destinations – intended as a response to capture a supposedly ‘rural’ lifestyle characteristic of post-modern tourists avoiding commercial overcrowding, traffic jams, and people concentration during both night and day (Tsartas, 2003).

These newly urbanized territories exhibit a heterogeneous mixture of uses, encompassing service-oriented infrastructure, such as commercial, industrial, and transportation facilities, alongside predominantly residential developments, which are largely second homes (Vandarakis *et al.*, 2023). Many of these constructions have progressively occupied land previously devoted to agriculture and pastures – that have been converted into private gardens, or remain fallow, creating landscapes characterized by fragmentation and medium-low ecological functionality (Karatzoglou and Spilanis, 2010). Ecologically, these areas function as interstitial zones of diminished habitat quality, highly susceptible to further conversion into urban/suburban uses. Informal soil occupation – basically from artisanal workshops, vehicle sales, and small-scale industrial activities – accelerated land consumption, intensifying the ‘weak’ soil sealing patterns typical of interstitial landscapes, threatening biodiversity and the stability of natural habitats (Mancino *et al.*, 2016; Tomao *et al.*, 2017; Wilson *et al.*, 2017; Quaranta *et al.*, 2020).

The demand for additional housing, which underpins the continued dispersion of settlements, is driven both by a residual population growth and, possibly, migratory inflows either from Greece’s major urban centers (Athens, Thessaloniki, Patras, Iraklio, Ioannina) and from abroad (*sensu* Lamonica *et al.*, 2020). These flows involve diverse demographic groups, including retirees (usually from affluent, Western and Northern European countries) seeking seasonal or permanent residences, and younger workers (often immigrants) pursuing employment, mainly (but not exclusively) in the tourism sector (Briassoulis, 2007). Without the implementation of robust local conservation policies, the remaining open spaces adjacent to low-density settlements are at risk of progressive fragmentation and environmental degradation, threatening both landscape integrity and ecological

resilience (Incerti *et al.*, 2007; Kosmas *et al.*, 2015; Ferrara *et al.*, 2016; Biasi *et al.*, 2019).

When considered at the regional level, Mykonos presents a distinctive developmental profile, functioning as a central tourism hub that attracts substantial and continuously increasing seasonal inflows, a pattern not observed across the majority of the other Cyclades islands. Aside from a limited number of comparably developed tourist destinations – such as Santorini, Paros, Syros, and Naxos – the remainder of the archipelago has maintained relatively well-conserved landscapes. Land-use analysis indicates that cropland and natural habitats have persisted in greater proportions than on Mykonos (Detsis *et al.*, 2010; Salvati *et al.*, 2012; Colantoni *et al.*, 2015), a condition attributable to moderate and stable human pressures, with settlements tending toward compact, dense configurations rather than overly dispersed sprawl (Stott, 1985, 1996; Tsartas, 1992, 2003; Cuadrado-Ciuraneta *et al.*, 2017). Understanding this double role – when a tourism-specialized island simultaneously exhibits local sprawl while contributing to regional settlement consolidation and environmental conservation – is critical for devising planning strategies capable of mitigating soil depletion and landscape degradation (Briassoulis, 2007; Canfora *et al.*, 2017; Francaviglia *et al.*, 2019). The complexity of such dynamics is further compounded by the interplay of multiple anthropogenic drivers, whose interactions influence environmental outcomes (Fares *et al.*, 2017; Wilson *et al.*, 2017; Ferrara *et al.*, 2020).

5. Conclusions

Suburban expansion within insular territories has emerged as a critical focal point within European research and policy discourse, reflecting the pronounced vulnerability of coastal landscapes to the pervasive spread of dispersed (and often unregulated) settlements that undermine both ecological integrity and socio-spatial cohesion. In the context of Mediterranean Europe, a growing body of scholarship, alongside the initiatives of environmental advocacy organizations and regional governance authorities, has consistently underscored the multifaceted consequences of these settlement dynamics. These include the fragmentation of natural habitats, the progressive deterioration of soil and water systems, the disruption of ecological connectivity, and the gradual erosion of traditional land-use configurations, all occurring within territories inherently constrained by limited spatial extent and environmental resilience.

Addressing these complex phenomena requires the establishment of integrated monitoring frameworks that combine diverse methodological approaches – ranging from the systematic exploitation of official statistical datasets to the analysis of high-resolution (remote sensing) imagery and field-based mapping. These tools contribute to generate spatially coherent and temporally robust evaluations of settlement expansion, particularly in peripheral or semi-rural areas far away from dense urban cores. Elementary variables (mainly demographic and territorial) were demonstrated to effectively support

(methodologically rigorous and spatially harmonized) evaluations of settlement dispersion within insular contexts, thereby complementing remote sensing and *in-situ* observational approaches. Based on these information layers, interventions that are simultaneously multi-scalar and multi-objective, are increasingly required to reconcile the imperatives of economic development, social well-being, and environmental stewardship.

The effective planning of sustainable island development, therefore, requires the integration of spatial planning mechanisms, socioeconomic policy instruments, sustainable land management strategies, and targeted conservation initiatives into a coherent and comprehensive governance architecture. Such an approach is indispensable for addressing the 'scaling paradox' identified herein, wherein localized processes of settlement proliferation coexist with broader (regional) patterns of land-use consolidation and environmental protection, demonstrating the potential to accommodate demographic and economic pressures without compromising ecological integrity. These insights underscore the urgency of formulating governance strategies capable of navigating the intricate interdependencies between anthropogenic drivers, demographic trends, and ecological constraints, thereby ensuring the long-term resilience, functionality, and aesthetic quality of insular landscapes.

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