Assessing the Tourism Footprint in Dodecanese Complex, Greece – An Islands' Typology Approach

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Abstract. Tourism activity is by principle tightly intertwined with the distinct territorial context of each single destination. That said, the UNWTO anticipated surge in tourism flows, projected to reach 1.8 billion at a global scale by 2030, raises severe concerns as to the preservation of relevant territorial resources in popular but also emerging destinations, particularly those located in vulnerable and geographically-confined island regions. However, despite the nearly five decades of research and policy efforts in multi-level decision-making environments, highlighting the intricate relationship between tourist development and its territorial context, a certain deficit still exists with regards to the deployment of quantitative methods for fully assessing the territorial implications of tourism and informing sustainable tourism planning endeavours. Within such a context, this research advocates for the integration of territorial assessments of tourism into relevant planning exercises and policy decisions for attaining sustainability objectives in destinations, with a specific focus on insular regions. As such, the Dodecanese islands' complex in the South Aegean Region, Greece is considered, namely a region reputable for its diverse natural/cultural and tourism wealth as well as the discrete geopolitical importance in the eastern border of Greece. By use of spatial analysis tools and a set of indicators quantifying the spatial impacts of tourism, the study identifies clusters of islands according to a certain typology; thus initiating a vital discussion and providing evidence-based results useful for incorporating the territorial dimension in effective tourism planning in the Dodecanese islands' complex.

Keywords: Sustainable tourism and regional development · Tourism footprint · Spatial analysis · Dodecanese · Islands' typology

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1 Introduction

According to the UNWTO [1], tourism is defined as "*a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes*". This definition demonstrates the inseparable nature of tourism activity and the territorial context in which it takes place, rendering tourism a place-based activity [2]. In fact, tourism destinations are places mostly characterized by their "uniqueness", a quality that is largely grounded in the harmonious coexistence of natural and cultural wealth [3]. Such uniqueness demarcates the tourism landscape, attracts relative investments and shapes – in conjunction with other factors, e.g., tourism-related infrastructure, services – tourists' preferences in favor of a destination. The aforementioned statements ascertain that every tourism activity *is defined*, *occurs* and *refers* to a place; while it also *consumes and occupies* space [4], thus potentially creating positive but also negative repercussions; while can eventually exert severe pressure on local natural/cultural ecosystems.

The rapidly escalating tourism flows at the global level, trending to reach 1.8 billion in 2030 – i.e., 54% increase since 2015 – are predicted to even further intensify territorial consumption in order for the needs of tourists to be met [5, 6]; thus circumscribing the way tourism development is expected to project in space. Taking into consideration the statement of Pearce [7], claiming that the most common types of tourism development, so far observed, stand out for their spontaneous, pervasive and penetrating nature [8], this pattern, met in the Mediterranean region in general and Greece in particular, remains a major source of territorial pressure and related impacts in tourism-prominent areas [9–11]. These render *spatial planning* and related policies essential control mechanisms, especially in highly-rated tourism destinations, such as the insular ones.

In fact, *insular destinations*, i.e., top tourism destinations in the Mediterranean Region (Greece included), lie at the heart of this discussion as, according to Fernandes and Pinho [12], the "*islandness*" state affects the spatial and developmental pattern in insular territories both in a positive and negative manner, depending on the spatial distribution of terrestrial resources and the way these are managed in alignment with sustainability objectives. The islands' constrained but also vulnerable geographical space is, in most cases, accommodating: *high-valued natural and cultural capital* in need of protection and preservation [10, 13–15]; *sharper land use conflicts* for housing, agricultural, leisure etc. activities [16, 17]; and intense *tourism development*, being the outcome of glocal (global/local) real estate interest and the emerging tourism-oriented entrepreneurship [18, 19]. That said, spatial planning in insular territories is fraught with difficulties and challenges in the effort to manage the ever-increasing demand for "space" in such confined and fragile ecosystems; and the way such territories are evolving due to tourism. Concurrently, it is meant to compromise interests – economic, social, environmental, cultural, political, etc. – while safeguarding day-to-day needs of local communities.

Today, however, research focus on the tourism footprint in islands is mostly highlighting the social and environmental dimensions, e.g. water pollution, biodiversity loss and the COVID-19 aftermath [20]. In fact, only few studies have stressed the need to embed in relevant works the territorial context and the local attributes of the tourism sector by adopting a holistic approach, underlining the importance of such factors in

islands' future developmental patterns. At the same time, further research [4, 21, 22] and policy directions (e.g., EU cohesion policy 2021–2027) [23] endorse the integration of spatial dimensions into national/regional planning, tourism included; and call for the use of methods and tools that are capable of better grasping and representing the spatial footprint of tourism.

Towards this end, *tourism indicators* have currently gained a prominent position in assessing tourism footprint [24–26]. Such indicators apply to all types of destinations, including islands [11, 27]; and are widely used in policy and decision-making endeavours, targeting sustainability objectives [28]. The most commonly used ones relate to both tourism demand and supply, indicating the sector's growth patterns and dynamics [26, 28, 29]. In terms of the spatial impacts of tourism, indicator usage is extended through spatial analysis tools [30], where spatially-referenced data are used to highlight '*the possible importance of data spatial arrangement in the analysis or in the interpretation of results*' [31:137]. Contemporary research in tourism studies indicates that spatial analysis tools are used to demonstrate the pathways of tourists' movement in a destination or the tourism-related mobility means [32] as well as the motives to visit particular places and destinations [33]; and support tourism growth, attractiveness of a destination and tourism product development [34, 35]. In addition, special interest is placed in spotting environmental impacts in places where high valued natural resources and extended tourism development are noticed, e.g. coastal areas or islands [36–38].

Within such a context, a gap in *addressing tourism implications in spatial terms* is observed. That said, the focus of this research work is on highlighting the spatial repercussions of tourism – *tourism footprint* – as a necessary input in relevant planning endeavours that aim to achieve tourism sustainability objectives in insular regions. The study field is Dodecanese islands' complex in South Aegean Region, Greece, i.e., a highly-rated destination, marked by the uniqueness of cultural/natural wealth and a distinct geopolitical importance in the eastern border of Greece. By use of spatial analysis, this work illustrates the tourism footprint in each island of the study region; and, based on that, concludes with *an island typology*. In doing so, the following research questions (RQ) are set:

- RQ1: What are the *spatial implications* of tourism activity in the Dodecanese islands' complex and how such implications can be effectively measured?
- RQ2: What is the *typology of the islands* of the Dodecanese in terms of their current tourism activity and its respective spatial implications?
- RQ3: What is the role of such information in feeding policy decisions seeking to attain sustainable tourism development in insular regions?

In order to address these questions, this paper is structured as follows: in Sect. 2 data and methodology are presented; Sect. 3 sketches the study region; Sect. 4 elaborates on research results and the emerging islands' typology; while finally in Sect. 5 results are discussed and conclusions are drawn.

2 Data and Methodology

By focusing on the Greek Archipelago and particularly the Dodecanese islands' complex, South Aegean, this research aims to illuminate the spatial implications of tourism for feeding policy reaction towards sustainable tourism development. This exploration is a three-stage process (Fig. 1). It starts with the selection of the indicators' set (Stage 1) that can properly capture the effects of tourism at each single island's level. Then statistical elaboration of this indicators' set is conducted in Stage 2; and finally, interpretation of results (Stage 3) guides the structuring of an islands' typology in Dodecanese complex, based on the island-specific tourism footprint.

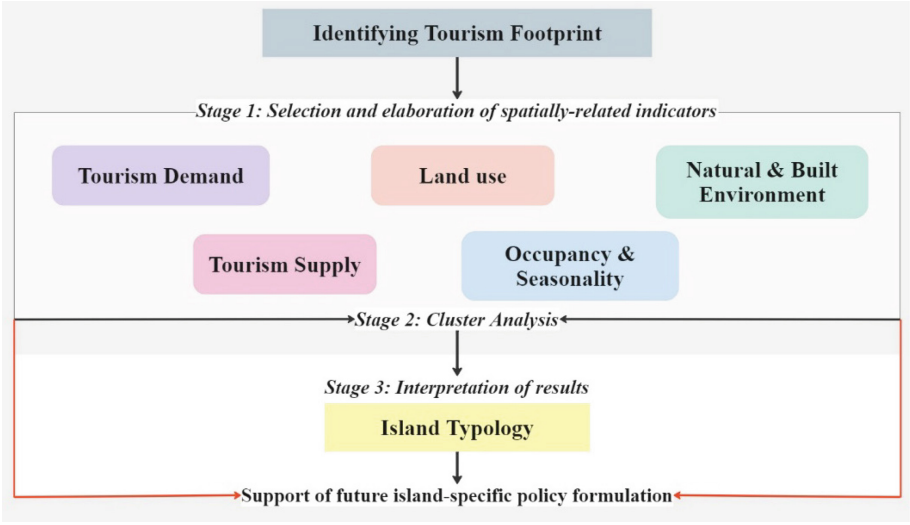


Fig. 1. Stages of the methodological approach, Source: Own elaboration

In more detail, each step of the methodological approach is described below (Fig. 1).

At *Stage 1*, a set of 14 indicators is selected and is classified into two broad categories, i.e., *sectoral* – tourism development both demand and supply side; and *spatial* – displaying the tourism footprint on land use, natural and built environment, etc. Selection of indicators is grounded in international evidence [24, 39, 40], further enriched by additional ones for more accurately representing local islands' peculiarities. The detailed list of indicators is displayed in Table 1, portraying the way these are calculated and the purpose they are serving. As spatial reference, the *municipalities* of the Dodecanese islands' complex are used (15 in total), as the lowest level for which relative data as to the tourism demand and supply side is available.

Going into specifics, the indicators' selection proceeds by taking into account the following *assumptions*:

- Indicators displaying *the impacts of tourism* incorporate: current accommodation supply, including both commercial and non-commercial types; annual tourism arrivals

in hotels and Airbnb; annual arrivals by air and sea – including internal ones – indicating tourism dynamics; and accommodation occupancy rates. In addition, intense *seasonality* observed in the studied islands calls for embedding this aspect in the way specific indicators are weighted, taking for granted a tourist season lasting from May to October, i.e., a total of 183 days [43].

- Indicators on *land use and environmental fragility* focus on the loss of agricultural land, expansion of the built environment and share of Natura 2000 protected areas. Their selection is based on the need to explore: imprints of the built environment on the fragile and contested island areas; agricultural land loss as the common victim of the rapid tourism construction fever of the last decade in island destinations [44]; high valued natural and cultural environment. These indicators derive from various data sources as well as from spatial analysis, combining different sets of geospatial data.

At *Stage 2*, Cluster Analysis is conducted for sorting Dodecanese islands into different groups, based on the combination of indicators selected in Stage 1. This is performed by use of the Hierarchical Clustering method. Ward's Linkage Method – or minimum variance linkage – was used, minimizing the increase in variance when two clusters were merged. Squared Euclidean distance was chosen as a measure of the distance between two clusters. At each step of the clustering process, the sum of squared distances within clusters was calculated; and the aggregated clusters were those resulting in a minimum increase in the overall sum of squares [45]. The method first includes a Z-score normalization of the initial variables.

At *Stage 3*, a qualitative interpretation of the produced island typologies is conducted, based on the shared behavior and attributes of tourism footprint. In fact, at this stage it is necessary to further explain the qualitative characteristics that have led to the structuring of the generated typology; present the key components of each cluster; link outcomes produced to the current tourism model of each island; and explore their positioning in future policy formulation endeavors in the Dodecanese Island complex.

The aforementioned statistical and spatial analysis processes are fueled with various *data sources* to reflect both tourism developments and their spatial repercussions. 2019 is used as the main year of reference for data collection of tourism flows, a year perceived as the most representative one before the pandemic outburst. In fact, data, sketching the contemporary tourism development patterns, are collected from the:

- Statistical Census of the Greek National Statistic Service (ELSTAT), corresponding to years 1991 and 2021.
- Yearly Report of the Aegean Sustainable Tourism Observatory (2019 data), providing tourism data on island municipality basis [41].
- Inside Airbnb Platform, providing beds' capacity/occupancy rate with reference to 2022.
- INSETE Intelligence, South Aegean Region's Annual Report on competitiveness and structural adjustment of the tourism sector (2021).
- Research Institute for Tourism, providing annual hotel arrival data for 2019.

Table 1. Formulating a new tourism impact-based island typology applied in the Dodecanese Island complex, Greece - List of indicators used, Source: Own elaboration based on [25, 39–42].

Indicator	Indicator description
T1 % population change	[(Total population 2021 – Total population 1991)/Total population 2021] * 100 T1 presents the percentage of population change during the last 30 years, highlighting population dynamics on the island level
T2 Tourism Accommodation Intensity	[Total tourist accommodation (beds)/resident] Tourist accommodation reflects the actual beds' capacity of each island, including the number of commercial beds in hotels and camping spots, as defined by the Greek National Statistic Service. Beds' capacity divided by the number of permanent residents represents the potential pressure (intensity) per resident due to the current tourism supply
T3 Tourism Accommodation Density	[Total tourist accommodation (beds)/island's surface] T3 represents the actual beds' capacity of each island, including all registered commercial accommodation types (hotel beds, camping spots, etc.) divided by the island's surface (area in km^2). It is used to sketch the tourism saturation level of each island
T4 Tourism Intensity (a)	[Total hotel arrivals/resident] There are several ways to measure tourism intensity. In this work, T4 displays the ratio of hotel arrivals to the local population on a yearly basis. Data about tourist arrivals are only available in terms of hotel registrations at the island level; while tourist arrivals in other commercial and noncommercial settings are missing
T5 Tourism Intensity (b)	[Total ship and airplane arrivals/resident] This indicator demonstrates the ratio of total arrivals by different transportation means (including maritime and air transport) to the local population on a yearly basis. T4 data limitations are held for T5 as well
T6 Tourism Density	[Total ship and airplane arrivals/island's surface] It calculates the ratio of total arrivals by different transportation means (including maritime and air transport) to each island's surface

(*continued*)

Table 1. (*continued*)

Indicator	Indicator description
T7 % Seasonal Population Density Change	[{[(hotel arrivals * hotel occupancy + Airbnb arrivals * Airbnb occupancy)/183 + local population]/island area}- population density] * 100 T7 estimates the % change in population density during the tourist season and takes into account the intense seasonality phenomenon observed in the Dodecanese Island complex between May - October [43]. Summer season is assumed to expand to 183 days in total
T8 Hotel Occupancy Rate	[Total number of rooms occupied divided by the total number of rooms available in each destination] Occupancy rate is the percentage of occupied rooms in a hotel accommodation at a given time. It is one of the most important indicators of tourism success. Annual data is used for 2022
T9 Airbnb Accommodation Intensity	[Total Airbnb accommodation (beds)/resident] T9 represents the total actual bed capacity in Airbnb of each island divided by the number of permanent residents; and highlights the potential pressure per resident due to Airbnb tourism supply
T10 Airbnb Accommodation Density	[Total Airbnb accommodation (beds)/island's surface in km^2] The actual number of Airbnb bed capacity in each island divided by the island's surface, displaying saturation levels of Airbnb at the island level
T11 Environmental vulnerability	[% area of each island falling into the Natura 2000 zones] It displays areas of highly-rated natural and cultural value
T12 Built-up areas	[% of each island covered by impervious (or built-up) surfaces in 2018] The classified change product (IMCC layer) has been used, and Classes 1 (new cover: from unsealed to sealed), 10 (unchanged sealed), 11 (increased sealing) and 12 (decreased sealing) were combined to identify sealed areas in 2018

(*continued*)

Table 1. (*continued*)

Indicator	Indicator description
T13 Built-up expansion	[% rate of growth of impervious (or built-up) areas in 2006–2018] Class 1 (new cover) was used to identify recent impervious land expansion areas, presenting a pivotal reference for geographically-constrained island regions
T14 Agricultural Impact	[% of total initial agricultural area (as identified by CLC 1990 zones) that has been impacted by urban development] It displays agricultural grid sectors presenting a dispersion of urban land >5%; and manifests vulnerability of agricultural land due to tourism

In addition, data used for calculating *spatial variables* emanate from the elaboration of:

- The Imperviousness dataset. This dataset is part of the Copernicus High-Resolution Layers. It is provided on a pan-European scale [46] and captures the spatial distribution of artificially-sealed areas. Sealed pixels are classified, based on the soil sealing level (imperviousness degree). Non-sealed areas are characterized by a value of IMD = 0%, while built-up areas are characterized by IMD values in the range of 1–100%. The IMP dataset captures accurately dispersed urban development and construction in agricultural areas, including various types of impervious surfaces that also contribute to the land take [47]. Impervious surfaces include a large set of structures, like housing areas and isolated buildings, industrial/commercial areas, roads, railways inside built-up areas, greenhouses, construction sites with discernibly evolving built-up structures, sealed surfaces associated with sport and recreation/tourist areas, etc. [48].
- The Corine Land Cover dataset [49]. This is the pan-European CORINE Land Cover inventory for 44 thematic classes with the reference years 1990, 2000, 2006, 2012, 2018. The dataset has a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a Minimum Mapping Width (MMW) of 100 m for linear phenomena. The dataset was used to identify existing agricultural areas in the early period of 1990, so as to specify the impact of new urban development on these scarce islands' productive soil resources.
- The Natura 2000 network [50]. The Natura 2000 (N2K) product offers a comprehensive overview of Natura 2000 sites, protected under the European Union's Habitats' Directive. N2K is currently updated every six years. These data were used to specify the environmental fragility of the case study islands.

In terms of digital tools used, statistical analysis was conducted through the SPSS software, while geospatial data were processed using the open source QGIS software.

Realization of the aforementioned steps can shed light on the current impacts of tourism, observed in the Dodecanese Islands' complex, i.e., an islands' complex in the Greek archipelago already characterized by mass tourism waves. The emerging typology presents the way these islands can be grouped on the basis of their similar tourism dynamics, providing critical input as to the spatial implications of tourism in each cluster for further exploitation in tourism planning endeavors.

3 The Dodecanese Islands' Complex

The aforementioned methodology is applied to the Dodecanese islands' complex, Greece, a cluster of 15 inhabited islands and 93 smaller islets at the southeastern part of the South Aegean Region (Table 2). It is a significantly diverse complex in terms of islands' size and population dynamics [51, 52]; accompanied by a substantial role in noteworthy historical events, both national and international, e.g. the Italian occupation during WWII and the late annexation to the Greek State in 1948 [53]. As a result, a vibrant cultural wealth, comprising numerous archaeological sites, medieval castles, architectural treasures and churches is left behind which, in combination with the scenic natural environment, strengthens tourism attractiveness of these islands. Tourism represents a salient sector, counting more than 3.8 million recorded hotel arrivals in Dodecanese islands in 2019 [41], i.e., 69% of total arrivals recorded in South Aegean Region as a whole (Table 2). This is also witnessed through the share of Dodecanese complex in hotel beds, owning the highest percentage in the Southern Aegean Region in 2019 (74%) [43]. Noticeable is also Airbnb bed availability, appearing in addition in small islands, e.g. Symi, Karpathos and Astypalaia. However, each island's tourism profile is significantly diversified, acknowledging islands characterized as famous mass tourism destinations, e.g., Kos and Rhodes; and islands demonstrating a rather alternative, authentic tourism profile, e.g. Astypalaia, Chalki, Symi and Kasos. Also, important to notice is that in 6 out of the 15 Dodecanese islands the whole land area is identified as Natura 2000 zone, proving the particularly vulnerable – and of top conservation priority – ecosystems, owned by these insular territories.

Table 2. The islands of the Dodecanese Complex in numbers, Source: [41, 43, 52, 54].

Dodecanese Municipalities	Population (2021)	Island's size (km^2)	Population Density (2021)	Hotel arrivals (2019)	Total commercial beds' capacity (2019)	Airbnb beds' capacity (2023)
Agathonisi	185	13.50	15.04	–	145	2
Astypalaia	1,399	96.85	14.34	3,729	3,872	504
Kalymnos	16,179	110.88	136.49	27,906	15,341	1,190
Leipsoi	790	15.98	49.68	2,450	1,730	115
Leros	7,917	52.95	137.06	21,328	8,996	477
Patmos	3,047	34.05	79.55	24,495	5,469	891
Karpathos	6,226	301.18	20.44	89,157	20,563	1,103
Kasos	1,084	65.98	18.25	719	2,774	28
Kos	33,388	290.28	128.87	1,295,163	80,445	2,173
Nisyros	1,008	41.40	25.42	2,752	4,953	173
Megisti	492	9.13	63.69	2,568	1,233	92
Rhodes	115,490	1,398.08	89.07	2,398,116	183,950	13,134
Symi	2,590	58.10	41.61	10,473	4,692	576
Tilos	780	62.83	12.04	5,917	3,479	108
Chalki	478	28.13	17.49	2,488	1,916	141
Total	**191,053**	**2,579**	**74.08**	**3,887,261**	**339,558**	**20,707**

Data collected and elaborated witnesses a significantly uneven distribution of tourism in the 15 insular municipalities of the Dodecanese complex (Fig. 2), advocating Sharpley's statement [55] as to the uniqueness and strongly place-based pattern of islands' tourism. In the following, an attempt to classify Dodecanese islands according to their tourism growth patterns and related implications is conducted in support of a more place-based and locally-adjusted policy formulation towards more sustainable tourism pathways.

4 Dodecanese Islands' Typology According to Tourism Footprint – Results

In this section, results obtained by the proposed methodology are presented, highlighting the different island typologies, grounded in each island's tourism footprint.

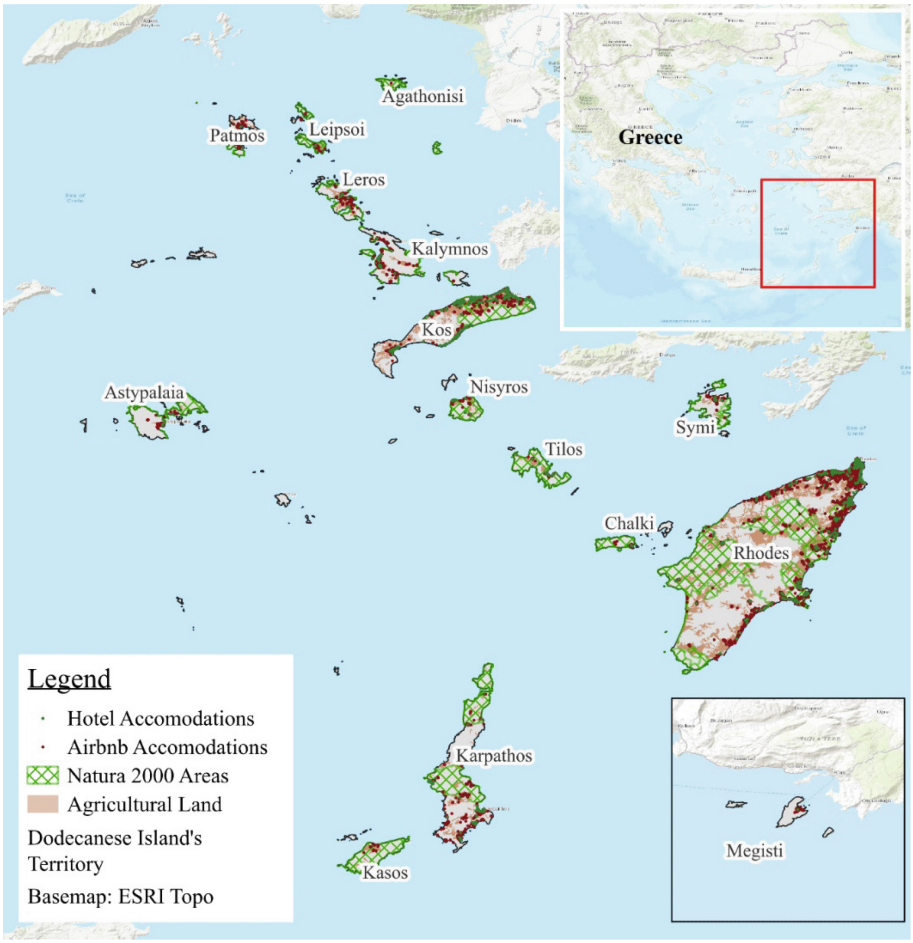


Fig. 2. The spatial pattern of tourism in Dodecanese Complex, Source: Own elaboration

In *Stage 1*, calculation of the 14 indicators provided a comprehensive image of the current tourism footprint in each single island of the Dodecanese complex. Indicator values confirm that Dodecanese Islands, overall, *are significantly affected by mass tourism*; while considerable variations are observed in their tourism profiles. Tourism Accommodation Intensity (T2) ranges from 0.72 in Agathonisi to 4.73 in Nisyros; while Tourism Accommodation Density (T3) shows even more diverse results, with values ranging between 10.8 (Agathonisi) and 279.5 (Kos). The Tourism Intensity Index as to the hotel

arrivals (T4) scores higher in three islands, namely Karpathos (13.58), Rhodes (19.17) and Kos (34.92); while when total arrivals are considered, Kos, Patmos and Symi are the islands with the highest scores of 75.9, 60.4, and 44.2 arrivals per citizen (T5). Kos, Rhodes and Karpathos display also the most significant increase in seasonal population density (T7), ranging between 35.9% and 56.9%; followed by Tilos, Chalki and Patmos (increase between 20–25%). Thus, in these islands seasonal population considerably exceeds the permanent local one.

Hotel Occupancy Rate (T8) is higher in Rhodes, Kos and Karpathos (>50%). It is interesting to notice that T8 is, in most islands, relatively very low (<40%); this fact confirming the high seasonality of the Dodecanese islands' tourism profile, with almost all arrivals reported during the summer period (May to October). Airbnb development is recently affecting Greek islands. However, according to indicators T9 and T10, only Astypalaia, Nisyros, Tilos, Kasos and Rhodes Islands are already hosting a relatively large number of Airbnb beds, compared to their population or size.

Regarding the spatial implications of tourism, built-up areas in Karpathos, Leros, Nisyros and Kalymnos occupy relatively high percentages of the islands' space (T12 is between 3–4.27%). In these islands, the impact of urban development on agricultural areas (T14) is also important, ranging from 9.4% in Leros to 24.8% in Karpathos. In Astypalaia and Agathonisi, large percentages of agricultural land are also already lost. Built-up expansion rate (T13) is over 8% in Kos, Symi, Leros, Karpathos and Megisti; this fact confirming that tourist development has an ongoing and accelerating spatial footprint, already affecting small, not necessarily mass and well-known tourism destinations.

In *Stage 2*, the 14 indicators are used as input to the Hierarchical Cluster Analysis. Clusters are visually represented in the dendrogram of Fig. 3. Based on the results, five (5) clusters were selected as an optimal choice, as less clusters would result in a more aggregated picture, and important information regarding the particularities of the case study islands would be lost. Final cluster memberships are mapped in Fig. 4, while the mean values of the initial indicators per cluster are displayed in Table 3.

Following a qualitative interpretation of the emerging island typologies (Stage 3), each cluster is analyzed as follows:

- *Cluster 1: Islands with limited tourist influence* (Kasos, Leipsoi and Agathonisi): islands falling in this cluster present a considerably low tourism profile, coupled with population stagnation. Both tourism density and intensity scores are very low. Environmental vulnerability is low and impact of tourist development on agricultural land is relatively high due to the considerable scarcity of such land resources. Construction activity is practically absent.
- *Cluster 2: Islands with significant Airbnb presence and high environmental vulnerability* (Astypalaia, Karpathos, Tilos, Chalki and Nisyros): islands marked by important Airbnb development and relatively high tourism intensity. However, arrivals and stays are still low in respect to their geographical area/size. Environmental vulnerability is high, while the impact of tourism on agricultural land is rather low.
- *Cluster 3: Rapidly increasing locally-driven tourism growth with limited seasonality* (Kalymnos and Leros): islands with low tourism intensity, yet relatively high tourism densities and tourism accommodation densities. The local population is growing and

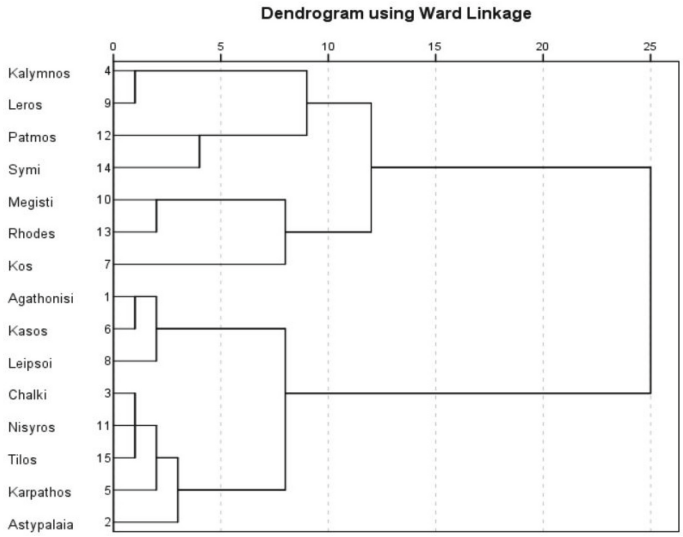


Fig. 3. Dendrogram identifying the Hierarchical Clustering steps of cluster analysis, Source: Own elaboration.

built-up areas occupy large shares of available agricultural land. These cannot be categorized as mass-tourism islands and are mostly based on a locally-driven growth.

- *Cluster 4: Islands with high tourism performance and impact* (Kos, Rhodes, Megisti): islands displaying important tourism and population dynamics, coupled with high rates of built-up expansion. The tourism dynamics are mostly attributed to the official tourism sector (hotel accommodation), leading to a high concentration of beds and arrivals and a rising seasonal population density. Airbnb development is up to now relatively low in comparison to the hotel sector. Especially for Megisti – i.e., a particularly small island –, its grouping in Cluster 4 is mostly attributed to high population growth and high tourism density in respect to its size.
- *Group 5: Dynamic tourism destinations growing at a steady pace* (Patmos and Symi): islands presenting a special typology with stable population and built-up areas, but important Airbnb development and very high tourism density, based on total arrivals. Environmental vulnerability is low and the impact on agricultural land is relatively high. Overall, they seem to rise to dynamic tourist destinations, sharing some similarities with islands of Clusters 2 and 3.

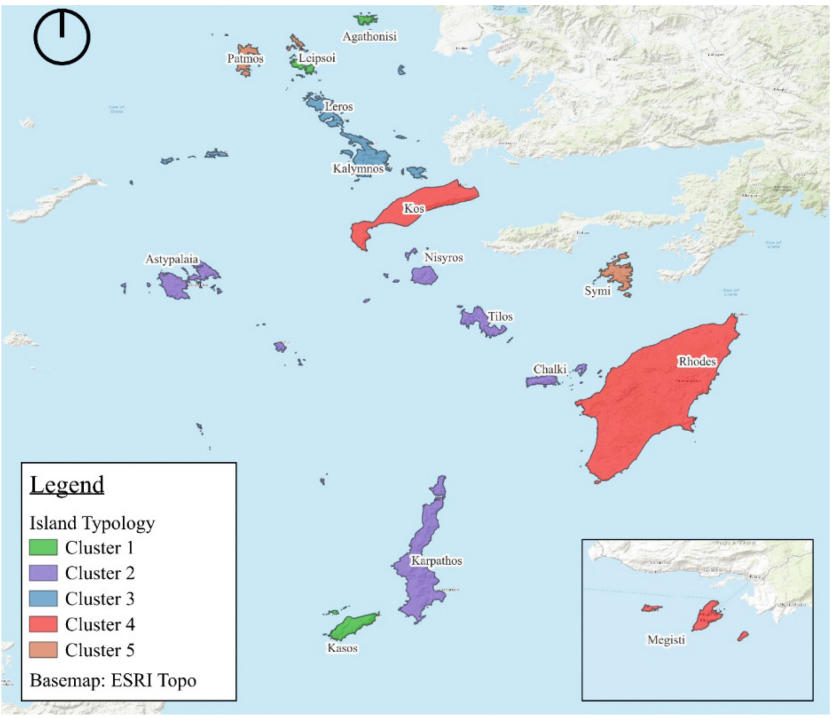


Fig. 4. Dodecanese islands' typology, based on the current tourism footprint and its spatial implications, Source: Own elaboration.

Island typology is a very helpful tool for better grasping the tourism dynamics, assessing their implications on land and local population, defining carrying capacity limits and identifying shared growth patterns and risks at each single island level. Based on the cluster analysis applied in this work, different islands' typologies were identified in the Dodecanese complex, ranging from islands with limited tourism presence (e.g. Kasos and Leipsoi) to very dynamic, of global outreach, mass tourism destinations (e.g. Rhodes and Kos); coupled with several cases in-between, better conceived as being in a transitional stage towards more dynamic tourism growth. Up-to-date tourism implications on the Dodecanese islands demonstrated that tourism growth is not only a matter of size and population density. On the contrary, very small and small islands are already approaching alarming levels of touristification, threatening local natural and cultural wealth and local communities' well-being. Concurrently, increasing vulnerability of those islands to global challenges, e.g., climate change is noticeable.

Table 3. Mean value per explanatory variable/per cluster of islands, Source: Own elaboration.

Cluster	T1	T2	T3	T4	T5	T6	T7
	Population change	Tourism Accomod. Intensity	Tourism Accomod. Density	Tourism Intensity (a)	Tourism Intensity (b)	Tourism Density	Seasonal population density change
1	−2.20	1.73	53.75	1.23	17.57	537.76	5.50
2	3.65	3.87	70.24	6.42	22.34	396.19	22.67
3	6.89	0.99	136.11	2.12	10.86	1,485.33	7.47
4	36.45	1.92	181.64	19.50	31.48	3,192.87	38.89
5	0.00	1.73	103.76	5.74	67.69	3,963.06	19.62
	T8	T9	T10	T11	T12	T13	T14
	Hotel Occupation Rate	Airbnb Accomod. Intensity	Airbnb Accomod. Density	Environ. vulnera-bility	Built-up area	Built-up expan-sion	Agricultural Impact
1	11.63	0.09	3.00	100.00	1.06	2.49	11.00
2	31.48	0.34	5.88	75.57	0.60	5.60	4.07
3	35.45	0.08	12.10	5.21	3.62	7.11	23.33
4	51.67	0.15	12.69	54.31	3.05	19.79	4.64
5	32.30	0.32	23.27	24.35	2.20	4.94	10.06

5 Discussion and Conclusions

Identification of island typologies is critical for providing a better insight into tourism growth patterns and dynamics in such territories [56]; and thus guiding more informed and place-based tourism policy decisions. Such typologies have so far been established by taking into account the tourist demand and supply pattern and have already been used in articulating tourism policy.

Speaking of the Greek context, the revision of the "Special Framework of Spatial Planning and Sustainable Development for Tourism" is currently in progress, representing a key policy instrument in respect of the spatial development of tourism at the national level for achieving tourism sustainability objectives. This Framework aims at providing strategic, nationwide guidelines for tourism development as well as regulatory measures, taking into account the spatial variations of the sector as well as its environmental and socio-economic impacts. The newly proposed revision, expected to be soon announced and institutionalized, classifies the national territory (islands included) into a number of distinct categories, thereby stipulating different sets of measures/strategies for each single one of them. More specifically, typological divisions suggest five (5) tourist development classes. These are grounded in demand and supply figures [57], and are: Saturated Areas, Developed Areas, Developing Areas, Aid Areas, and Areas under Selective Special Support. Additionally, islands receive a separate distinction, based on

their population size, demonstrating thus a nuanced approach in order for the diverse attributes of these specific areas to be properly addressed. Such typologies, fall short of fully capturing the actual developmental and spatial footprint of tourism activity; thereby, more solid scientific methods are needed in order for the typologies produced to be robust.

The present study highlighted this necessity and developed a methodological approach that adopts an integrated view of tourist development, attempting to establish linkages between tourism demand and supply on the one side and the socio-economic, environmental and spatial contexts these refer, on the other. This approach is applied to the Dodecanese Islands' Complex, where quantification of the tourism footprint and its spatial repercussions by dedicated indicators and application of hierarchical cluster analysis, lead to more transparent and robust islands' grouping. Results produced confirm: i) the importance of the spatial dimension for apprehending the footprint of the tourism sector in already developed and developing destinations; ii) the value of simultaneous consideration and interpretation of different tourism-specific and spatial indicators in order for the sector's footprint in terms of intensity, density, type and island's vulnerability to be defined, assessed and properly inform policy reaction; iii) the particular weaknesses of insular territories that call for further attention and strategic planning choices in the tourism sector; and iv) the peculiarities of small islands which, due to geographical limitations and small population size, are more vulnerable to tourism (over)load. Indeed, island groupings – grounded in the developmental and spatial implications of tourism – provide a solid ground for planners and decision-makers in support of tourism transition pathways to sustainability, by offering critical information of insular areas with regard to their current state, the saturation level in spatial terms, the (cultivable) land loss, the spatial distribution of tourist accommodation as well as the local population dynamics against tourism waves.

In conclusion, accommodating intense tourism development in the land-constrained, vulnerable and fragile insular territories is a quite distinct and demanding planning exercise; and a real challenge for planners and policy makers around the globe, given the tremendous natural and cultural attractiveness of these land parcels and the massively escalating tourism trends. Delving into the current tourism footprint in social, economic, environmental, cultural and spatial terms in conjunction with the Tourism Carrying Capacity [58] of each distinct type of island seem to be the starting point and a well-established ground for planning a future trajectory of these peculiar spatial entities that is sustainable and resilient, fair for their population but also appealing to visitors, while well-rooted to their historical trajectory through the centuries.

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