



Spatial planning incompetence to discourage urban sprawl on Greek Islands. Evidence from Paros, Greece

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Abstract

The urban sprawl is considered a major issue with irreversible impact on local socio-spatial systems mainly in peri-urban areas, coastal zones and on islands. Mass tourism development and the demand for a second house has led to residential pressure, mainly in exurban areas, where the spatial planning system has not been discouraged. This paper attempts a quantitative yield of urban sprawl on Paros island, through a time series data analysis. The change in densities of built-up areas and the impact of the urban sprawl on natural and cultural heritage of the island are examined. The results are interpreted from a critical approach to Greek spatial planning framework.

Keywords Spatial planning · Urban sprawl · Islands · Paros · Greece

Introduction

The built-up environment on islands

Restructuring the built-up environment of islands

The spatial structure of the built-up area on islands has had two patterns: compact and disperse development, which have led to completely different socio-spatial systems. In the present paper, it is considered that compact residential development promotes socio-economic benefits and sustainable environmental management in a more efficient way (United Nations 1992; De Smet and Laplume 2019; Sun et al. 2019). It allows the preservation of existing land uses, reduces the dependence on vehicles and facilitates public transportation or walking. In terms of economics, the cost of providing and maintaining infrastructures is reduced. From a

social perspective, compact residential development allows the proximity of different social strata, thus increasing social equity and encouraging the mix of land uses (Rérat 2012; Abdullahi et al. 2018). Residential development in Mediterranean cities has changed from a compact and dense spatial structure into a discontinuous and dispersed development in exurban areas, thus affecting land uses (Salvia et al. 2018). Nevertheless, disperse built-up areas development is not only a phenomenon in metropolitan and urban areas but also in rural areas, and it is usually met in coastal zones and on islands, where tourism is developing (Salvati 2013).

The location and the structure of settlements on islands are based on physico-geographical characteristics, historical coincidence and political choices. Since antiquity natural harbors have been a common location of settlements for accessibility reasons in the Aegean Sea, because the transport of products and people's movements have always done by the sea. From the sixth century to the beginning of the ninth century AD, piracy affected the location and the structure of settlements, thus leading populations to settle on the hills, limiting their proximity to the sea but ensuring sea visibility and protecting populations from pirates (Kizos et al. 2017). Those settlements were compact with specific architecture (Sinou 2006). After the piracy era had ended, small settlements started being developed in sea proximity and activities like fishery and trade started taking place again.

From the 17th to the nineteenth century, the main occupation of the islanders concerned agriculture and animal

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husbandry. Most of the Aegean islands were characterized by physico-geographical discontinuity, steep slopes and barren terrain that led to special agriculture practices, the most are widespread on terraces which shape an extensive landscape that is typical of the islands (Savo et al. 2014). The contribution of the secondary production sector to the cultural heritage of the islands is also important to be underlined. Of particular significance for industrial heritage are shipyards. Moreover, on every island there is a local production of agricultural products - such as cheese, wine etc. - hand-made works, such as pottery, which are activities that have been developed on the (Greek) islands since antiquity.

This cultural heritage that has emerged from the primary and secondary production sector and from the monuments of Greek ancient civilization was a source of attraction for the first travelers. Thus, although tourism began to be an issue that required management in the mid-twentieth century, the appearance of travelers goes back to the 18th and 19th centuries. The purpose of those travelers' visit was different from that of those of today, since they placed emphasis on the ancient cultural heritage and the sea. In 1930s, travelers were mainly artists who interested in landscape, traditions and islanders' everyday life (Belavilas 2017). However, when mass tourism in Greece started booming after the middle of the twentieth century, it brought changes in land uses, settlement structure and the landscape. That has as a consequence a pressure on the landscape, since tourists have been attracted to different resources. They are usually not interested in cultural heritage, as the old travelers were, but they have a very specific picture of Greek islands that focuses on 3S (sea, sand, sun) (Terkenli 2001; Currie 2018).

The economic profits from tourism are multiple compared to the primary and secondary sectors and this has as a result for the latter to have been shrunk. Traditional agricultural and production structures - such as windmills, cobbled streets, cisterns, terraces etc. - which are considered as cultural heritage and landmarks on the landscapes of the islands - have been abandoned and/or destroyed (Savo et al. 2014). In addition, mass tourism has led to land use conflicts with agriculture, animal husbandry, fishery, extraction processes and the natural and cultural environment (Terkenli and Schistou 2016; Tsilimigkas and Rempis 2018). In the present work, it is considered that mass tourism development and the demand of second houses have led to intensive housing pressures within the boundaries of settlements or/and in exurban areas.

Tourism development and housing pressure

The change in the built-up environment of the islands is pronounced, and it has taken place through intensive, unplanned and spontaneous procedures in a few decades. On the one hand, the built-up environment has been developed by

self-promoted housing strategies that are mostly driven by market dynamics (Kizos et al. 2017; Tsilimigkas and Derdemezi 2019). On the other hand, housing pressure - such as the demand of second houses - has led to the increase in residential densities within settlements boundaries and/or urban sprawl in the exurban areas. Residential densities and/or urban sprawl in the exurban areas are two forms of residential development on islands, which are both mainly impelled by tourism and the demand of second houses, but they are different in the structure of residential patches that are formed and in socio-spatial issues they raise.

The sustainability of the development of settlements depends, among others, on residential density. Low residential densities are potentially more sustainable, especially, if they are combined with mixed land uses and adequate public space (Ghosh et al. 2007). Nevertheless, there is a threshold of density under which a settlement is considered scattered, and it does not facilitate the placement of urban functions and structures. Residential development within settlement boundaries is an expected legitimate process. However, in many cases, although there are institutionalized settlement boundaries on Greek islands, since the second half of the 1980's, there have been no Urban Studies (US) ('Poleodomiki Meleti', in Greek) that can determine, among other things, specific building conditions; instead, there have been general building conditions. Despite the fact that these terms and building conditions are strict - especially for traditional settlements, they are inadequate to ensure sustainable residential development. Residential densities within the settlements of the islands are intense and, due to the absence of US, there have been no land use plans, protected areas delineation and appropriate public space. As a result, the residential density of the settlements has come to exceed the carrying capacity of the socio-spatial system, especially during tourist season.

Another issue has been the time lag between mass tourism development on islands and the implementation of local planning studies, so that land use plans and buildings conditions are institutionalized. On the one hand, on many islands tourism development began in 1960s, so the first constructions for tourist demands were placed within settlements, and were both incongruous to the dominant local scale and incompatible with local architecture (Tsilimigkas and Derdemezi 2017).

On the other hand, urban sprawl has had an uncontrolled, uncoordinated and unplanned growth in built-up areas in the exurban areas (Sun et al. 2019), and it has been a common practice on islands and in coastal areas. Tourist demand, combined with the "loose" spatial planning system, has led to ad-hoc practices in residential development in exurban areas. There are two main typologies: (1) the linear one, which goes either along coastal zone for sea proximity or along roads for accessibility, or on ridges so there can be

an attractive view; and (2) clusters around the settlements boundaries so that the already existing urban infrastructures, services and facilities can be employed (Kizos et al. 2017; Tsilimigkas and Derdemezi 2019). The absence of land use plans and specific buildings conditions has impelled the exurban built-up expansion that is at the margin of law many times. The state has shown particular tolerance to these practices made by its political clientele in Greece. Thus, every field can be constructed without any provision for necessary social and technical infrastructures. Subsequently, the state, being under political pressure, has legalized these clusters of built-up areas, and has been made to provide necessities, such as roads, sewage, power, drinking water, etc. (Karidis 1996, 2008).

In Greece, land ownership has considered as a means of profit, and phenomena of extreme speculation have been taking place. This aspect was manifested in the 1960s when the former profitless coastal fields and land on the islands were converted into high value real estates and the investment in coastal zones and on islands was the safest choice. (Andriotis 2006). The investment could be either scattered tourism facilities or second houses, practices that have intensified coastalization and urban sprawl. Coastalization or costality is here briefly explained as the attractiveness of the space for residential use, related to sea proximity or sea visibility (Kizos et al. 2017; Kioussopoulos and Stathakis 2009). It is a kind of ribbon urban sprawl that is very common in Mediterranean coastal areas and islands (Serra et al. 2014; Lagarias and Sayas 2018).

This process of residential development have led to non-resilience built-up areas and have created issues such as: environmental impact on the natural resources, pressure on the compact residential tissue, degradation of the cultural heritage in peri-urban zones, pressure on the landscape and high cost in creating and maintaining infrastructures and services for dispersed residential zones (EEA 2016). This procedure has, finally, led to hybrid clusters rather than to sustainable settlements.

Installation of buildings that serves tourism follows two main typologies: (1) small scattered units within settlements boundaries or in exurban area; and (2) large organized units in exurban areas. In Greece, small and medium tourist enterprises have prevailed because of small-scale land ownership and tourism policy that has been implemented since 1980s (Sarantakou and Terkenli 2019).

A widespread practice for buildings within settlements boundaries is to preserve the shell of the old buildings and to change the use; that is, mainly former residences have been converted into tourist services and shops, thus leading to informal forms of tourism accommodation (Sarantakou and Terkenli 2019). This practice has caused intense pressure on settlements due to the fact that the users of the place excessively increase spatially during the tourist

period, so additional or new facilities are needed (organized parking, public transport services, market place etc.). Small scattered rooms to let are located in exurban areas too, which is an activity that is considered as a driving force for urban sprawl. A common practice is landowners to transform land use of their property from rural into a tourist one, by employing old rural buildings and/or by building new ones (Salvati 2013; Salvati et al. 2014).

An effort to organize tourism units was made by The Greek National Tourism Organization (GNTO), which was founded in 1950. The organized hotel units did not lead to urban sprawl; instead, they put pressure on the landscape of islands, instead. Those accommodations usually exceeded the dominant local scale of islands, and the necessary infrastructures led to visibility issues (Tsilimigkas and Derdemezi 2020).

As mentioned earlier, apart from mass tourism development that has led to urban sprawl, the demand for second houses has also been a critical factor. Second houses are used either as seasonal homes or as a solution for quick getaways by natives or foreigners of various ages. However, the mainstream view has been connected with elder people in retirement, who migrate seasonally or permanently to coastal zone or islands searching for a new lifestyle (Stergiou et al. 2017).

Within this context, the scope of this paper is to propose a pertinent methodology in order to quantitative assessment of urban sprawl on Greek islands, through a time series data analysis that can be applied in many similar cases. Here, we consider the urban sprawl as an important, irreversible, environmental problem for sensible *socio-spatial* systems, as the Greek one. The built-up areas dispersion puts pressure on local, natural and cultural heritage, as well as on the landscape of the islands and the coastal areas. For the implementation of the methodology, the island of Paros has been chosen and the appropriate data have been collected or constructed. The quantitative results concern the change over time of the built-up within settlement boundaries and exurban built-up area of Paros that affect the cultural and natural heritage of the island. The change over time of the density of exurban built-up area of Paros have been examined by Kernel function, and its variables are based on Law 3889/2010 (OGG 2010).

The aim of the study is to illustrate the connection between an incompetent spatial planning system and the loose planning practice, adopted for many decades, and the excessive built-up areas dispersion observed, especially on Greek islands and coastal zones. Although we recognize the importance of the social and economic driving forces, we consider the spatial planning incompetence as the principal parameter that encourages the built-up areas dispersion.

An overview of Paros Island

Natural and human environment

The evidence of the present study comes from Paros island, which is located in the center of Cyclades island complex in the Aegean Sea. Paros is the fourth biggest island of Cyclades, with total area 193.45 km² and permanent population is 13,715 people (EL-STAT 2011). Paros belongs to the South Aegean Region (NUTS 2) and to the Regional Units (NUTS 3) of Paros that consists of the Municipalities (LAU 1) of Paros and Antiparos (Fig. 1).

Paros is characterized by steep geomorphology, it has the typical Cycladic flora of shrub and grassland. The areas Akrotiri, Santa Maria, Molos and the butterfly valley belong to the network Natura 2000 (OGG 2011a). The whole island is considered as Landscapes of Outstanding Natural Beauty (LONB) ('Topia Idiaiterou Fysikou Kalous or TIFK', in Greek) (OGG 1950, 1975). On Paros

there are also nine (9) island small wetlands (OGG 2012a), and three (3) wildlife refuges ('Katafygio Agrias Zois', in Greek) (OGG 1977, 1985a, 2000a).

The economy of Paros is based on tourism, since it is one of the most accessible islands in the Aegean Sea, because it has both a port and an airport. Although primary production sector was dominant on island in the past, nowadays it has been abandoned. Since 2009, constructions of tourism infrastructures and second houses have become the primary sector, instead (Spilanis et al. 2009).

On the island, there are twenty-four (24) settlements with official settlements boundaries: ten of which are nominated traditional settlements, according to Presidential Decree (PD) 594/D/78 (OGG 1978) and to PD 504/D/1988 (OGG 1988a). The terms and building conditions for traditional settlements are included in PDs, PD 594/D/79 was reformulated according to PD 345/D/89 (OGG 1989). On Paros there are eight nominated archaeological sites of which one is in the marine space (OGG 1972, 1979a, b, 2000b, 2002a, 2006, 2011b, 2019).

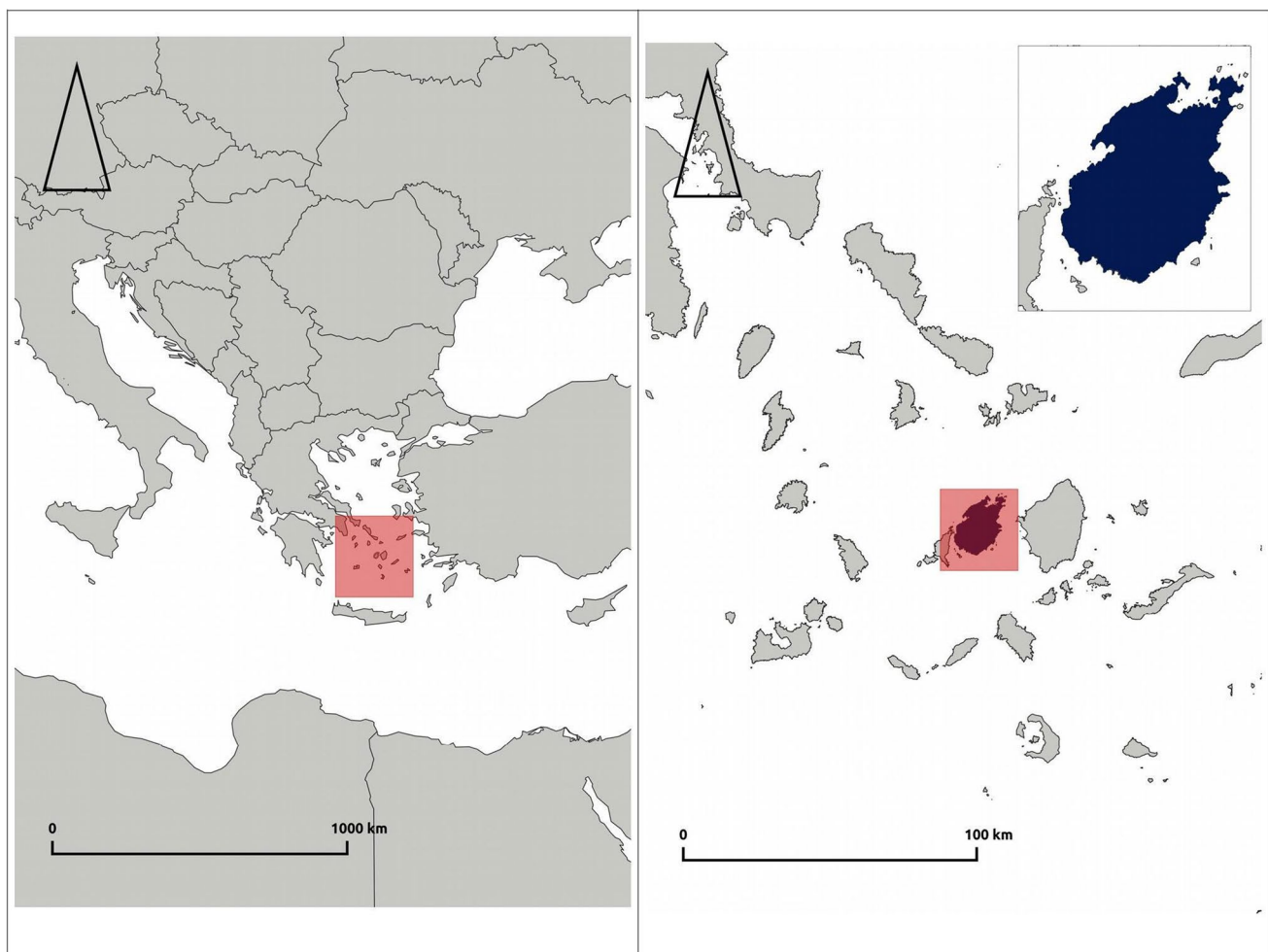


Fig. 1 Location map for Paros Island. Source: Authors' analysis

Spatial planning on Paros

Although Paros has extensive residential areas development, both within settlements and in exurban areas, the appropriate tools of spatial planning that could have regulated and organized the built-up development have yet to be enacted. The delineation of settlement boundaries, the nomination of the traditional settlements and the terms and building conditions for them are the main institutionalized spatial interventions. The effort to implement Urban Study (US) has not succeeded, on the one hand, due to the rigidity of spatial planning tools and, on the other hand, due to the significant expectation of speculation from land ownership. As a result, the built-up area expansion has been unregulated, and has led to excessive residential densities and urban sprawl.

The main spatial statutory regulations that have affected the built-up development of the island are: (1) according to the Legislative Decree (LD) 17.07.1923 (OGG 1923) the settlements of Paros pertain to the category of pre-existing of 1923 without urban plan; and (2) according to PD 594/D/78 (OGG 1978), the nomination of seven traditional settlements was considered as a first step towards architectural heritage protection. In 1988, three more settlements were nominated as traditional (OGG 1988a), enhancing the protection of cultural heritage. The terms and building conditions for traditional settlements were completed and amended according to PD 345/D/89 (OGG 1989). The delineation of settlements on Paros has been according to PD 181/D/85 (OGG 1985b) and the amendment of PD 414/D/85 (OGG 1985c). Although the process of the delineation had specific methods and steps, land owners exerted political pressure on local administration that led to no pertinent choices, often enlarging the settlement delineation. In 1988, according to PD 533/D/88 (OGG 1988b), the Urban Development Control Zone (UDCZ) ('Zoni Oikistikou Elegchou', in Greek) for the area Kolympithres was delineated.

In the 1990s and 2000, many efforts so that residential areas could be sustainably managed were made. They mainly concerned the two largest settlements of the island, Parikoia and Naousa, when General Urban Plans (GUP) ('Geniko Poleodomiko Schedio', in Greek) and USs tried to be implemented. However, those effort did not have pertinent results.

Concerning Parikoia, in 1990, a GUP was implemented by PD 220/D/1990 (OGG 1990a). The following fifteen years, numerous USs for part of Parikoia were implemented, according to PD 998/D/93 (OGG 1993a) and PD 743/D/95 (OGG 1995). However, four years later PD 743/D/95 was invalidated by the Council of State, with PD 927/D/02 (OGG 2002b), which was also invalidated by the Council of State in 2007. Regarding Naousa, a US was implemented with PD 463/D/90 (OGG 1990b) and, subsequently, with PD 529/D/93 (OGG 1993b), with which land use and building

conditions for the areas Agioi Anargyroi and Piperi were implemented.

As far as the exurban area is concerned, land use and building conditions are enacted the following spatial statutory regulation zones: In 1993, by the PD 732/D/93 (OGG 1993c) that concerns the total area of Paros island and subsequently in 1997, by the PD 375/D/97 (OGG, 1997), for cape of Agios Fokas (OGG 1997a). Lastly, in 2012, there is the first spatial statutory regulation that concerns the total area of Paros island, a GUP was implemented (OGG 2012b).

Materials and methods

Working scale

In this study, data spatial structures that have been used are both vector and raster, and the coordinate reference system is the Greek Geodetic Reference System 1987 - GGRS87. Two typical spatial planning scales are used: (1) the 1:5000, so that the official delineation of settlements, archaeological sites and UDCZ could be digitized; and (2) the 1:1000 as the most appropriate for constructing the data of the built-up area of the island in order for building digitalization to be as accurate as possible. Concerning the terrain of the island, there have been used: (1) the Digital Elevation Model (DEM) Aster DEM with 30×30 m cell size; (2) ASTER GDEM, which is a product of METI; and (3) NASA (METI AND NASA 2011).

Data

Variables 1: Built-up areas dispersion

While constructing data of the built-up area in Paros, our principal priority was to achieve the greatest accuracy (Fig. 2a). Thus, digitizing each building at scale 1:1000 was considered as the most appropriate method. The buildings were digitized with the aid of orthophoto maps that were provided by the National Cadastre and Mapping Agency (NCMA 2019).

In order for a time series analysis to be achieved, the appropriate dates should be chosen. The choice was based, on the one hand, on the availability of the data-set and, on the other hand, on socio-spatial changes that have affected the built-up development on the islands. First, the date that is considered here as the inception of built-up environment of the island should be identified, and this is 1945. It is the year of the end of World War II, mass tourism had not started yet, and in the orthophoto maps of that period is imprinted the origin structure and spatial distribution of the built-up areas. The built environment of that time could be considered as part of the architectural heritage of Paros.

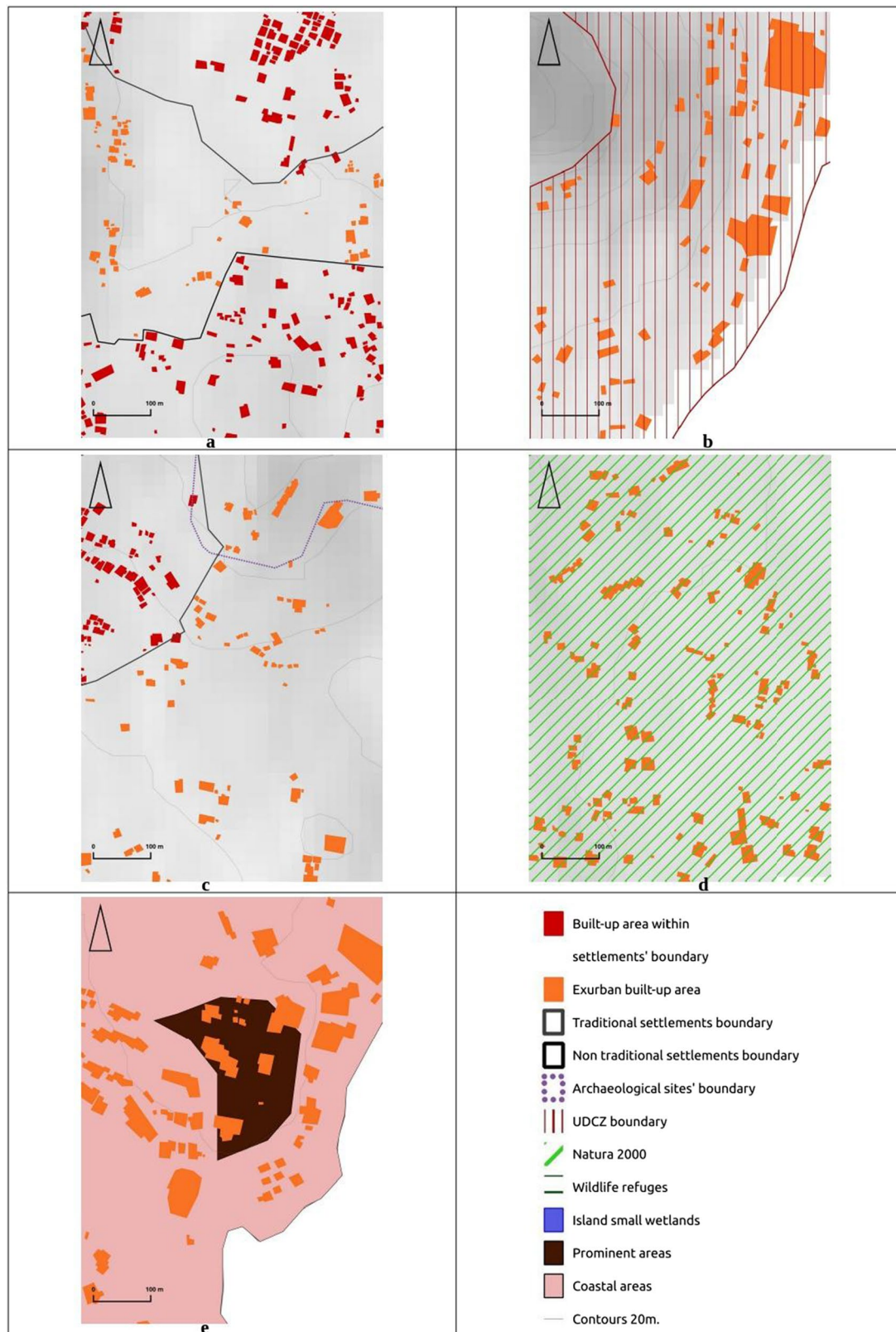


Fig. 2 Built-up areas issues on the official settlement delineation and the Cultural and Natural Heritage

The first steps for the management of Paros' settlements started after the second half of the 1980's, and they were only related to delineation and building condition of the settlements. That period the built-up expansion was intense, mainly in exurban areas and structures that could support rural activity. 2000 is a milestone year both for the change in built-up areas and urban sprawl to be examined and for the spatial planning system to be criticized for its role to regulate the built-up area dispersion.

From 2000 to 2009, there was a booming in general, and for construction, in particular, which continued to develop in Greece. The orthophoto map, which were shot from 2007 to 2009, are also considered substantial to be examined. With the help of the aforementioned tools, the rapid continuation of urban sprawl and the rigidity of spatial planning system can easily become conspicuous.

Finally, the current situation of the built-up area on Paros was examined. From 2009, when the economic crisis started in Greece, construction was affected but, because of ever increasing tourism development on Cyclades islands, the dispersion of built-up areas has been advancing until today.

Variables 2: Settlement boundaries and exurban areas zoning

The built-up area is clustered into buildings within official settlement boundaries and in exurban areas (Fig. 2b). The delineation of official settlement boundaries is available only in non-digital format, in topographic charts or orthophoto maps that are included in the respectively OGGs of settlements' delineation. These charts and orthophoto maps were scanned and projected on the reference system GGRS87, whereas the orthophoto maps provided by NCMA (NCMA 2019) were used as base maps, and then the boundary was digitalized. The process for digitizing UDCZ boundary (OGG 1988b) and the zones for exurban area of Agios Fokas (OGG, 1997) were similar. The area Kolymythres is a small wetland of high environmental significance, at the same time it is a popular beach and is located near Naousa, a very tourist area. The UDCZ (OGG 1988b) aims to protect this area from the unregulated built-up area expansion. Similarly, the zone in Agios Fokas, which is near to the capital settlement Parikia, has similar aim, that is, to protect the area from the urban sprawl.

Variables 3: Cultural Heritage, traditional settlements and archaeological sites

In order for the impact of urban sprawl on cultural heritage to be studied, both traditional settlements and archaeological sites were examined (Fig. 2c). The digitalized boundaries of traditional settlements were differentiated according to OGG 1978, 1988a. The process for digitizing

archaeological boundaries was similar as that of the official settlement boundaries according to various published OGGs.

Although the nomination of most archaeological sites comes after to that of the traditional settlements, traditional settlement boundaries were not taken into account. As a result, intermediate spaces are created that are not under the regime of special terms and building conditions, but they are near to those areas of significant cultural value. The built-up areas of unregulated exurban dispersion in these intermediate areas could create intense pressure on cultural heritage of the island.

Variables 4: Natural Heritage, “prominent” areas and coastal zone

In order for the impact of urban sprawl on natural heritage to be studied, there were examined: the Natura 2000 sites, wildlife refuges, “prominent” areas and the coastal zone (Fig. 2d). The boundaries of Natura 2000 sites of the European ecological network (OJEC 1992) are available in digital format. In these areas land use conditions and special construction regime are implemented (OGG 2011a). Wildlife refuges concern areas of particular ecological value (OGG 1986, 2014a).

Within this context, “prominent” areas are defined as areas with wide visibility from different sides. To determine “prominent” areas, the geomorphology of Paros island has been studied, using GIS methods. The result is ten terrain categories, of which summits and ridges were considered as “prominent”.

The coastal zone has been identified according to the terrain and the sea proximity. The terrain was categorized based on the elevation and the slope (Table 1), thus the following three categories were resulted: Level areas, Semi-Fragmented areas and Fragmented areas. The sea proximity was identified by three consecutive buffers from the coastline (Table 1).

| | |
|---|---|
| Variables 1: built-up areas dispersion | Variables 2: Settlements boundaries and exurban areas zoning (UDCZ) |
| Variables 3: Cultural Heritage. | Variables 4: Natural Heritage |
| Variables 4: “prominent” areas and coastal zones. | Legend |

Source: Authors' analysis

Methods

Density maps

In order to answer the study questions (i.e. to quantitative the urban sprawl in Paros island using a time series

Table 1 Coastal zone identification according to terrain categorization, which was based on elevation and slope, and the sea proximity

| Category synthesis | Criteria |
|------------------------------|--|
| Level areas | Plane area: elevation 0 – 100 m and Flat area: slope 0–5% Plane area: elevation 0 – 100 m and semi-Steep area: slope 5–20% |
| Semi-Fragmented areas | Transition zone: elevation 100 – 300 m and Flat area: slope 0–5% Transition zone: elevation 100 – 300 m and semi-Steep area: slope 5–20% Mountainous area: elevation 300 < m and Flat area: slope 0–5% |
| Fragmented areas | Plane area: elevation 0 – 100 m and Steep area: slope 20 – <% Transition zone: elevation 100 – 300 m and Steep area: slope 20 – <% Mountainous area: elevation 300 < m and semi-Steep area: slope 5–20% Mountainous area: elevation 300 < m and Steep area: slope 20 – <% |
| Coastal | Level areas Within 200 m Buffer zone Semi-fragmented areas Within 200 m Buffer zone Fragmented areas Within 200 m Buffer zone Level areas Within 500 m Buffer zone Semi-fragmented areas Within 500 m Buffer zone Level areas Within 1000 m Buffer zone |

Source: Authors' analysis

data analysis) and in order to interpret the impacts of this process on cultural and natural heritage, a methodological approach was considered necessary so that the compact of exurban built-up areas to be identified. The methodological approach has been based on the relevant legislation for residential densities. Residential densities are defined by Law 3889/2010 (OGG 2010) as areas out of official settlements boundaries, out of the boundary of nominated US or others spatial plans and regulatory zones; they are not considered as legally existing settlements that have nominated boundary compact exurban built-up areas.

More specifically, residential densities are defined according the minimum number of buildings to be a cluster and the average ratio number of the area of residential density as well as the number of buildings in them (OGG 2010). The area is considered as residential density if it meets the following criteria: (1) It has 50 buildings or more; (2) for 50 to 100 buildings there should be at least one building in an extend area 500m²; (3) for 101 to 400 buildings there should be at least one building in an extend of 1000m²; and (4) for 401 buildings and more there should be at least one building in an extend of 2000m² (OGG 2010).

Residential densities consist of areas that have defined in the framework of forest maps designation, and there have been many amendments for their management. In this study, the aforementioned analysis and criteria have been taken into consideration for creating density maps of the exurban built-up areas on Paros (Fig. 3).

In order for 50 buildings to be considered as a residential density, there should be an area extent of 25000m². Thus, Kernel analysis was applied for centroid of digitalized buildings of the exurban areas. The radius has been set to 90 m, and the Kernel function is the predetermined Quartic. The contours of equal density with interval between contours line 1 m. are exported from the density map, and, then, the

line vector data was converted into a polygon. Residential densities (Fig. 3) were defined according the extent area of each polygon and the number of buildings that fall within it.

Results and discussion

Built-up areas dispersion within settlements boundaries and exurban areas zoning

The total area of Paros island was calculated 193.45 km². In 1945, the built-up area occupied 0.45 km², which was approximately 0.23% of the total island area; in 2000, the built-up area occupied 2.6 km² which means 1.34%; in 2007–09, the built-up area occupied 2.93 km², which means 1.52%, whereas, nowadays, the built-up area occupies 3.21 km², that is, 1.66% of the total area. The increase in the built-up area is notable because, despite the fact of the economic crisis, there has been an increase in built-up areas (Table 2).

When the residential change in built-up area within settlement boundaries and exurban built-up areas was examined separately, it was expected that the highest percentage of built-up area within settlement boundaries in 1945, whereas since 2000 the percentage of built-up area in exurban areas has been higher, and it has been increasing in a fast rate. On the one hand, the process of the settlement boundary delineation was not based on objective criteria and, in many cases, the real boundary of settlements has not been taken into consideration. On the other hand, the spatial planning system has proven inadequate to impede urban sprawl (Table 2).

The urban sprawl on Paros island is so intense that residential densities, according to Law 3889/2010 (OGG 2010), have been shaped in exurban area (Fig. 3). The built-up area near the settlements of Parikoia have led to hybrid clusters

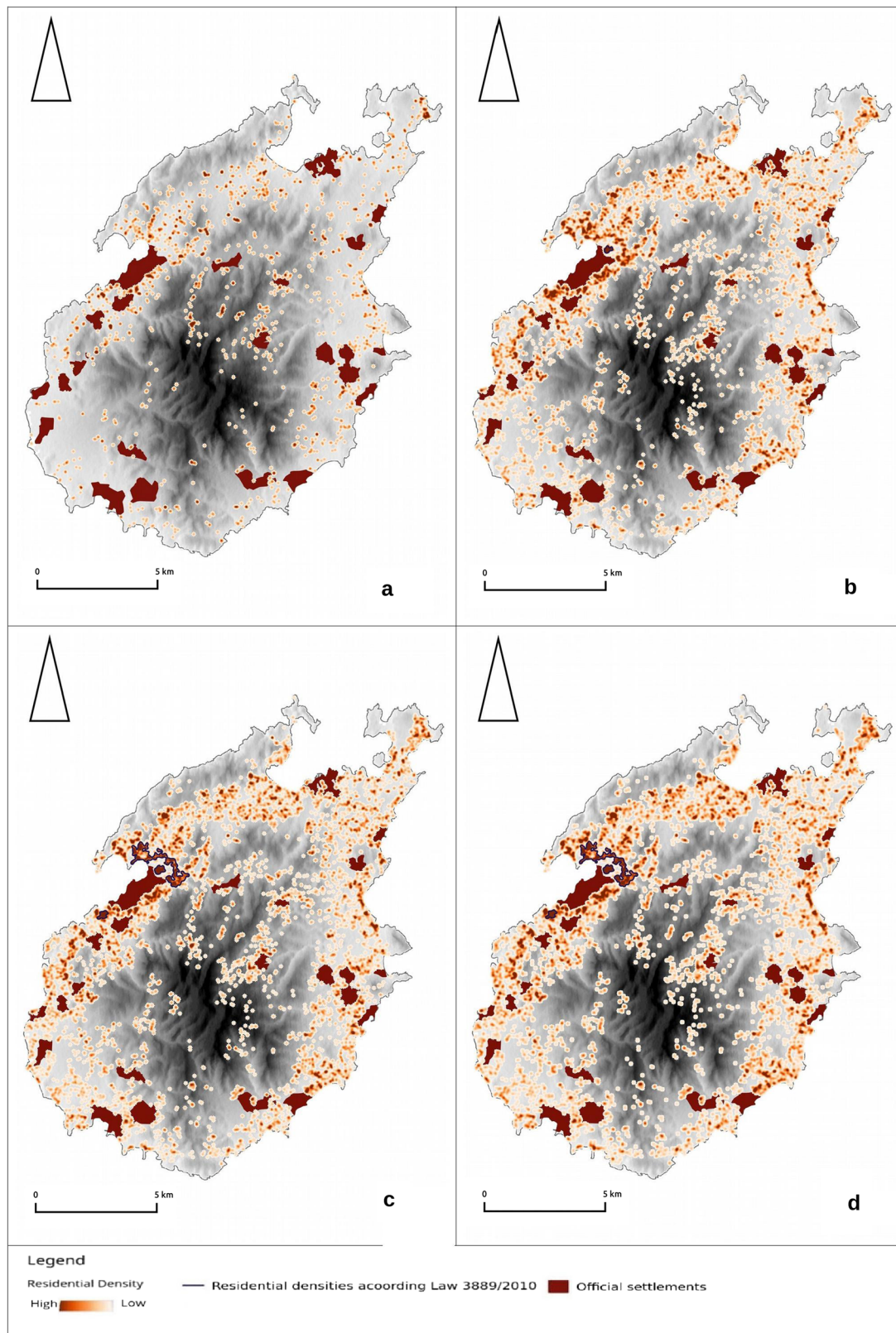


Fig. 3 Density map. Source: Authors' analysis

Table 2 Built-up area dispersion and its impact on natural and cultural heritage

| | | | 1945 | 2000 | 2007–09 | 2020 |
|---|--|-------------------------|-------------------|-------------------|-------------------|-------------------|
| | | | km ² % | km ² % | km ² % | km ² % |
| Variables 1,2: built-up areas dispersion | Total built-up area | | 0.45 0.23 | 2.60 1.34 | 2.93 1.52 | 3.21 1.66 |
| | built-up area within settlements boundaries | | 0.24 52.2 | 1.01 38.8 | 1.06 36.2 | 1.10 34.3 |
| | exurban built-up area | | 0.21 47.8 | 1.59 61.2 | 1.87 63.8 | 2.11 65.7 |
| | UDCZ | | 0.002 0.4 | 0.04 1.5 | 0.04 1.3 | 0.04 1.2 |
| | exurban zones of land use and building condition | | 0 | 0.01 0.4 | 0.01 0.3 | 0.01 0.3 |
| Variables 3: Cultural Heritage | Total built-up area | Traditional settlements | 0.19 42.2 | 0.66 25.4 | 0.68 23.2 | 0.7 21.8 |
| | | Archaeological sites | 0.07 15.5 | 0.2 7.6 | 0.24 8.2 | 0.25 7.8 |
| | built-up area within settlements boundaries | Traditional settlements | 0.19 42.2 | 0.66 25.4 | 0.68 23.2 | 0.7 21.8 |
| | | Archaeological sites | 0.05 11.1 | 0.1 3.8 | 0.1 3.4 | 0.1 3.1 |
| | exurban built-up area | Archaeological sites | 0.02 4.4 | 0.1 3.8 | 0.14 4.8 | 0.15 4.7 |
| Variables 4: Natural Heritage | Total built-up area | Natura | 0.02 4.8 | 0.09 3.3 | 0.13 4.5 | 0.16 5 |
| | | Wildlife refuges | 0.01 2.9 | 0.06 2.4 | 0.06 2.1 | 0.08 2.5 |
| | | “prominent” | 0.03 6.3 | 0.15 5.7 | 0.18 5.9 | 0.25 7.8 |
| | | coastal zones | 0.22 48.9 | 1.59 61.1 | 1.8 61.1 | 1.96 61 |
| | built-up area within settlements boundaries | Natura | 0.002 0.4 | 0.009 0.3 | 0.02 0.7 | 0.02 0.6 |
| | | Wildlife refuges | 0.003 0.7 | 0.004 0.1 | 0.004 0.1 | 0.004 0.1 |
| | | “prominent” | 0.009 2 | 0.04 1.5 | 0.04 1.3 | 0.05 1.6 |
| | | coastal zones | 0.13 28.9 | 0.72 27.7 | 0.76 25.6 | 0.79 24.6 |
| | exurban built-up area | Natura | 0.02 4.4 | 0.08 3 | 0.11 3.8 | 0.14 4.4 |
| | | Wildlife refuges | 0.01 2.2 | 0.06 2.3 | 0.06 2 | 0.08 2.4 |
| | | “prominent” | 0.02 4.3 | 0.11 4.2 | 0.14 4.6 | 0.2 6.2 |
| | | coastal zones | 0.09 20 | 0.87 33.4 | 1.04 35.5 | 1.17 36.4 |

Source: Authors' analysis

that have been shaped by spontaneous, self-promoted housing strategies that they have put pressure on cultural and natural heritage of the island (Fig. 4). Concerning the exurban area zoning, the UDCZ and the exurban zones of land use and building conditions and the percentage of the built-up area have increased noticeably from 1945 until today, but they remain in low percentages. The UDCZ area has also been nominated archaeological site (Fig. 5), a fact that has complicated more building constructions.

In order for a time series data analysis to be achieved, four layers of the built-up area – those of 1945, 2000, 2007–09 and of 2020 – were overlaid, and the map of difference between layers that allows the visual comparison of the increasing of residential areas within settlement boundary and urban sprawl in exurban areas was exported.

Built-up areas dispersion within cultural heritage areas

In order for the impact of built-up area dispersion on cultural heritage to be examined, the situation in traditional settlements and archaeological sites has been compared

diachronically. In 1945, 42.2% of built-up area was in traditional settlements – that is, that actually this period represents cultural heritage of the island. In 2000, 25.4% of the built-up area within settlement boundaries was in traditional settlements. In 2007–09, 23.2% of the built-up area was in traditional settlements, whereas, in 2020, the percentage was 21.8% (Table 2). Although the built-up area has increased, the percentage of the total built-up area within settlement boundaries in traditional settlements has decreased, thus, proving that, on the one hand, special terms and building conditions of traditional settlements have prevented the intense building in them, but, on the other hand, in combination with the absence of appropriate spatial plans, they have impelled the exurban built-up dispersion.

In 1945, the percentage of the built-up area that was in archaeological sites was 15.5%, and it concerned mainly the built-up area within settlement boundaries. However, since 2007–09 the percentage of the exurban area has been increased (Table 2), this making the urban sprawl be a main factor of pressure on cultural heritage.

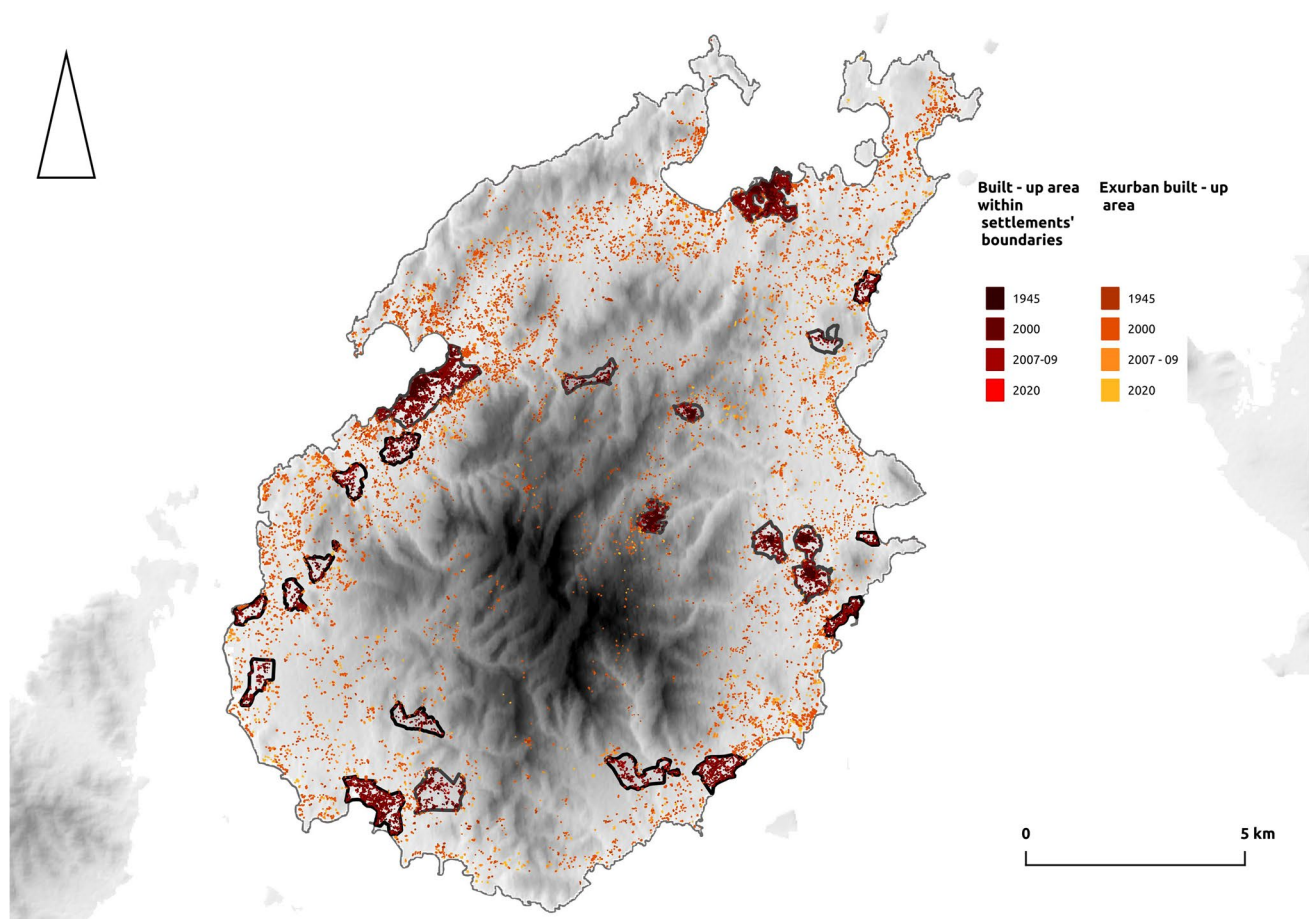


Fig. 4 Overlaid maps of the built-up area (those of 1945, 2000, 2007–09 and 2020). Source: Authors' analysis

Built-up areas dispersion within natural heritage, “prominent” areas and coastal zones

In order for the impact of built-up area dispersion in natural heritage to be examined, the Natura 2000 site, wildlife refuges, “prominent” areas and coastal areas were compared diachronically. In 1945, the percentage of built-up area in Natura area was 4.8%; in 2000, the built-up area was 3.3%; between 2007 and 2009 the built-up area was 4.5%, whereas, today, it is 5%. The highest percentage of these areas is related to exurban built-up area (Table 2). Wildlife refuges have been lightly affected from the exurban built-up area (Table 2).

In 1945, in “prominent” areas the built-up area was 6.3% of the total built-up area, the percentage was high due to historical and economic reasons (threat of pirates, primary production sector); in 2000, it was 5.7%; between 2007 and 2009 was 5.9%, whereas, today, it is 7.8%. This increase is due to the exurban built-up area, which since 2000 has got the highest percentage when compared to that within settlement boundary built-up area (Table 2).

In 1945, in coastal areas the built-up area was 48.9% of the total built-up area, which concerned primarily the built-up area within settlement boundaries. In 2000, the built-up area was 61.1%; between 2007 and 2009, the built-up area was 61.1%, whereas, today, it is 60%. The increase in built-up area in the coming years would be remarkable, while the higher percentage concerns the exurban built-up area, showing the crucial issue of coastalization.

Source: Authors' analysis.

Conclusion

Change of a compact to a disperse settlement tissue: Environmental economic, social issues

Through the present study, the change in the structure of settlements on Paros island has become conspicuous. The compact settlement tissue has converted into disperse leading to a number of issues at an environmental, a socio-economic and a cultural level that are even more pronounced on islands

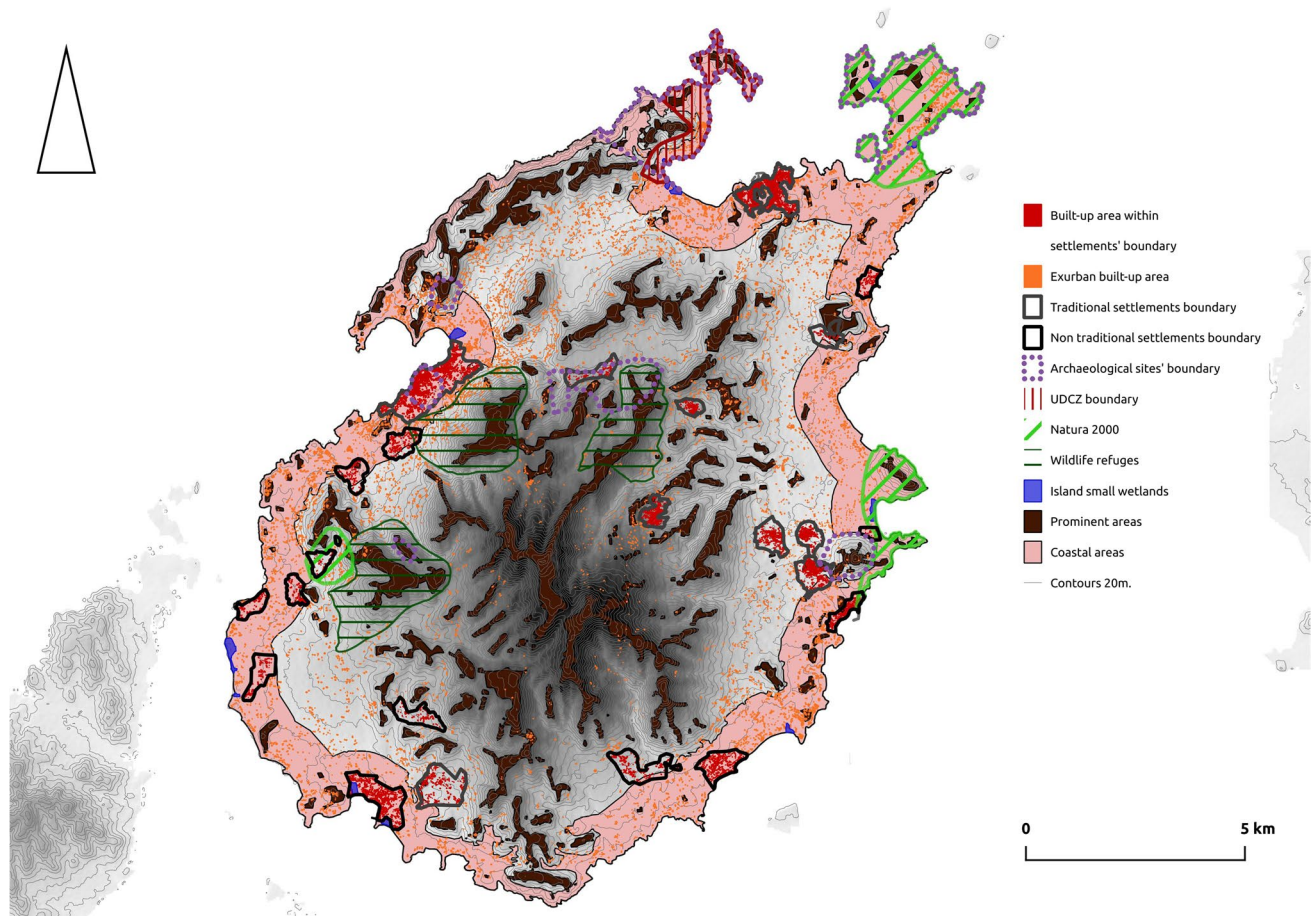


Fig. 5 Urban sprawl and its impact on natural and cultural heritage of Paros island. Source: Authors' analysis

due to their vulnerable socio-spatial systems (Baldacchino 2004). Urban sprawl creates low-density settlements, which is one of the main threats to sustainable territorial development, thus causing an irreversible loss of the ecological functions of soil (Prokop et al. 2011).

At an environmental level, the urban sprawl, consumes valuable land resources, obstructs water absorption, changes the micro-climate and increases the car-dependency (Tsilimigkas et al. 2018). At a socio-economic level, urban sprawl transforms rural societies into urban ones, thus increasing the cost the per-person infrastructure. At a cultural level, urban sprawl could lead to aesthetic issues and may threat the cultural heritage of the island (Tsilimigkas and Kizos 2014; Prokop et al. 2011).

As shown from the results, on Paros, and mainly in both in peri-urban zone of Parikoia settlement, which is nominated traditional settlement and is the capital of the island, intense residential densities have been shaped, which are out of settlement boundary but are not the result of a planned process. Therefore, these areas are considered hybrid clusters that do not ensure sustainable urban development. Moreover, natural and cultural heritage of the island receives

intense pressure both from urban sprawl and unregulated, non-sustainable residential densities.

The incompetence of spatial planning framework to restrict the exurban built-up area dispersion

The land use change through spontaneous self-promoted strategies has been a common practice on islands, and depends on the interaction between supply and demand that ought to be regulated by decision making and implementing land use planning. The spatial planning framework that has been enforced on Paros, which have been analyzed earlier, is no exception; it is rather the rule on Cyclades islands. The absence of strategic and physical US has led both to urban sprawl and to residential densities that exceed the carrying capacity of settlements.

The quantitative and time series data analysis have shown that the existing spatial planning tools are incompetent to intervene in the built-up dispersion. Residential pressures exerted by mass tourism and second houses have not been regulated, and the negative spatial footprint from this activity is obvious on islands. In the 1980s, when the settlement

boundaries were nominated and the first Law on urban planning was enacted (OGG 1983), many tourism accommodations had already been established. Tools such as GUP, UDCZ and Open City Spatial and Housing Organization Plan (OCSHOP) ['Schedio Chorikis kai Oikistikis Organosis Anoichtis Polis', in Greek] by Law 2508/1997 (OGG 1997b) either have lagged in their sanction or there has not been made enough effort to ensure proper management of exurban areas.

The best solution to the interception of the exurban built-up area dispersion is the integrated spatial planning at local level and its timely and accurate implementation. GUP and OCSHOP are considered as the prerequisite land uses regulatory plans. Nevertheless, after 45 years of efforts, approximate only 20% of the country's municipalities have approved such projects and about half of them need updating (MEE 2021). If UDCZ had been implemented for the total of national territory (obviously except: forest, archaeological areas and coastal zones), exurban building constructions, unsustainable residential densities and land use conflicts have been discouraged. Therefore, the aspect of land speculation through tourist development should be tarnished, and priority should be given to protect and manage natural cultural heritage that would ensure sustainable tourism development.

New era regarding the modernization of spatial planning legislation

In recent years, the institutional framework for spatial planning in Greece has undergone constant changes. More specifically, in 2014 the Law 4269/14 (OGG 2014b) was enacted, which replaced the hitherto active Laws 2508/97 (OGG 1997b) and 2742/99 (OGG 1999). Just two years later, the Law 4269/14 was replaced by the Law 4447/16 (OGG 2016), which has been replaced too by the most recent Law 4759/2020 (OGG 2020). According to the Law 4759/2020 the Greek spatial planning system consists of three levels: National, regional and local level. At the local level, the Law seeks, inter alia, for the country to acquire land uses, settlements and boundaries of urban units, terms and building conditions through the enactment of Local Urban Plans (LUP), which may concern one or more municipal units.

The same Law seeks to restrict the construction in areas for which there is no spatial planning and provisions for urban development. The main regulations are about the reduction of the building factor in plots of land that are over 4000m², while for those that are below 4000m² after two years without obtaining a building permit, the constructions will be prohibited.

The constructions in areas that are out of the boundaries of urban plans is a thorny issue in Greek spatial planning that leads to the urban sprawl. The purpose is the LUP to

be institutionalized with priority on islands and areas with intense tourist development or special issues and gradually to be carried out for the whole territory. If this endeavor succeeds, it will be the first time that whole Greece will acquire urban plans and will have integrated spatial planning at local level. If this venture is also combined with the timely restriction of constructions in areas that today are out of settlement boundaries or urban plans or there is not land use plans, it will be a very significant step against the urban sprawl.

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