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Spatial Planning and the Traditional Settlements Management: Evidence from Visibility Analysis of Traditional Settlements in Cyclades, Greece

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ABSTRACT

Traditional settlements constitute part of the cultural heritage and their preservation is an important priority, acknowledged in the present study as a multidisciplinary, multi-scale and complex issue. This study quantifies the visual impact of traditional settlements in Cyclades that arise from structures which are considered to create pressure on the island landscape and negative visual impact. These structures disrupt the landscape continuity; they are both incongruous with the dominant local scale and incompatible with the forms and shapes that are appropriate on the Cyclades islands. This paper examines these issues in the context of the management of insular traditional settlements within the Greek spatial planning framework.

KEYWORDS

Spatial planning; cultural heritage; traditional settlements; islands; Cyclades; Greece

Introduction

Protection Framework of Traditional Settlements

Traditional settlements are an integral component of the cultural heritage which is recognized as part of the identity of a place. The preservation and transmission of cultural heritage are not only a state responsibility but also an international priority. Traditional settlements have both material and immaterial characteristics, the maintenance of which requires special policy and an appropriate legislative framework. Climate change, massive tourism and urban sprawl are considered among other matters to create pressure on island traditional settlements (CEMAT 2000; Yiannakou *et al.*, 2017). Spatial planning is a precondition to prevent such situations and to provide solutions based on sustainable principles.

In Greece, the protection of traditional settlements has been delayed (Papapetropoulos, 2003). In 1973, the first attempt was made with the General Building Regulation (GBR) ['Genikos Oikodomikos Kanonismos', in Greek] and complemented by Law 880/1979 (OGG 1979). Subsequently, in 1985 the law was amended and special conditions and building restrictions were laid down for traditional settlements (OGG 1985). Provisions concerning traditional settlements exist in both GBR of 2000 (OGG 2000) and the most recent Regulation of 2012 (OGG 2012).

Many traditional settlements are both declared historical or archaeological sites, so they are also protected by archaeological legislation that precedes other provisions. The

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Greek Constitution of 1975 and its revisions of 1986, 2001 and 2008 (OGG 1975, 1986, 2001, 2008b) were influenced by global declarations made by international organizations (ICATHM 1931, 1964; UNESCO 1972; ICOMOS 1987, 1999, 2008, 2011, 2014) and European policies (Council of Europe:, 1954, 1975a, 1975b, 1985, 2000) on the protection of cultural heritage, and include the institutional preservation of cultural and historical environment. Revisions have introduced the principle of sustainability which enhances further protection in these areas (Tsilimigkas *et al.*, 2015).

In 1975, the Ministry of the Interior commissioned a study to conduct a census so as to locate and evaluate traditional settlements. The specifications were based on those provided by the Council of Europe for the European Heritage Census (Council of Europe, 1969). Thus, 421 traditional settlements were institutionally recognized (OGG 1978). Subsequently and within the same context, in 2000–2003, the Ministry of the Aegean took steps to ensure the compatibility of new buildings and structures with the prevailing architecture in order to protect and promote the island traditional settlements. Furthermore, it was attempted to restore settlements by waving incompatible structures with the scale, forms and shapes that were considered inappropriate in the territory.

Spatial Planning and Landscape Management

In this study, we attempt to shed light on the pressures the landscape of traditional settlements receives. According to the European Landscape Convention (ELC): 'Landscape is an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors' (Council of Europe, 2000). From this definition, we derive that landscape studies are multi – sectoral, multi – dimensional and multi – scale. Many and various disciplines, such as natural sciences, social sciences, humanities and the arts, concern for landscape issues from different perspectives (Tress *et al.*, 2001). The key for the proper protection and management of the landscape is the collaboration of human and natural sciences (Tress *et al.*, 2001). The landscape has both material and immaterial dimensions (Tsilimigkas & Kizos, 2014), where the former are physical – geographical characteristics and human-made construction, while the latter involve the interrelationship between people and place, customs and traditions that have been developed and interwoven with space; it is what is called the 'spirit of the place' (ICOMOS 2008). Thus, the landscape should be dealt as a whole (i.e. it has a holistic character), whose individual parts are of variable extent and scale (Antrop 2017).

It is widely accepted that landscapes change and evolve according to natural processes and human activities, such as changes and development in: production techniques in agriculture, forestry and crafts, housing, transport and other structures, tourism and recreational practices (CEMAT, 2000; ICOMOS 2014). Although these processes of changing landscapes are anticipated and unavoidable, difficulties arise when these processes are carried out in a violent way, thus putting pressure on local socio – spatial systems and leading to landscape degradation (Bürgi *et al.*, 2017; Kizos *et al.*, 2017, 2018).

Issues of degradation of landscape quality are even more pronounced on islands and coastal areas. The characteristics of insularity have created unique and fragile landscapes of islands, which are under intense pressure at environmental, economic and social level (Spilanis *et al.*, 2009; Fonseca *et al.*, 2014). Main factors of landscape pressure are primarily: (1) massive tourism that is now the economic base of the islands; and (2)

the establishment of structures which are based on technological developments which are neither regulated by a spatial study nor consider the landscape itself, such as: wind turbines, new roads, mobile telephone antennas, mining activity, etc. (Tsartas, 2003; Fonseca *et al.*, 2014; Salvati *et al.*, 2017l).

Apart from issues of the impact on the tangible level, that is, on the physical dimension of the place, there are issues of impact on an intangible level too. Cultural landscape must be perceived as a useful resource for local sustainable development and, thus, there should be a real concern for its protection and proper management (ICOMOS, 2014). Within this context, it is recognized that the integration of the landscape into spatial planning procedures is a basic requirement for its protection and management. This view was adopted and highlighted by the European Landscape Convention (ELC) (Council of Europe, 2000).

Despite the adoption of the protection and management of culture by ELC in 2000, the Greek State adopted it in the national legislative system 10 years after its ratification. On the one hand, this delay is justified because of the non-binding nature of the convention and, on the other hand, due to rigidity, bureaucracy, and different political priorities (Vlantou, 2010, 2012). Despite the significant time lag, Law 3827/2010 (OGG 2010) is, nevertheless, indisputably a positive step towards sustainable development and landscape management, upon which considerable pressure has been put.

Furthermore, the incorporation of the landscape assessment into regional planning studies (MEECC 2010) has also been a concrete step towards landscape protection within the spatial planning framework. More specifically, the attempt to protect the landscape was embedded in the 'Specification studies—assessment, review and specialization of the institutionalized regional frameworks for spatial planning and sustainable development' ['Prodiagrafes meleton aksiologisis, anatheorisis and eksidikefsis thesmothetimenon periferiakon plaision xorikou sxediasmou kai aiforou anaptiskis', in Greek] (MEECC, 2010). Although there can be many arguments raised concerning the sufficiency and effectiveness of the methodological landscape approach, it is indisputable that for] the first time, an integrated landscape policy has been incorporated into the spatial planning framework.

A crucial issue with spatial planning and with proper management of the landscape is the third dimension, the height, and its inclusion in the Public Law Restrictions (Navratil, 2012; Kitsakis & Dimopoulou, 2016). Monuments, archaeological sites, traditional settlements and every landmark of a place requires special protection and, therefore, urban planning should take into consideration the height of buildings and structures in order to protect the visibility of landmarks (Kitsakis & Dimopoulou, 2016). The method of this study is based on the visibility analysis, providing an index that takes into consideration the height. It can be a useful tool both for spatial planning and landscape management not only because it gives a quantitative result for the current situation but it also considers implications for the landscape before decisions are made (European Commission, 2019).

Research Questions

Negative visual impact is an aesthetic pressure that is not simple to attribute quantitatively and objectively. The present study aims to introduce a method that quantifies the visibility pressure of traditional settlements. More specifically, the study has searched the area of the islands and the traditional settlements of Cyclades that have visual contact

with structures considered within this context that create negative visual impact (SwNVI). They are structures that serve tourism and technological developments but they do not consider particular characteristics of the island landscape. In order for the (research) question to be answered, two key issues should be addressed: (a) to define and create the geospatial data for SwNVI; and (b) to define the delineation of traditional settlements.

At this point, it should be useful, first, to provide a definition of the SwNVI, and then, to discuss how the necessary data were constructed. On the one hand, in order to define the SwNVI, a proper literature review and fieldwork was conducted. It was considered that the Cycladic islands have similar spatial structure and character and, thus, the same massive structures generate negative visual impact on every island and traditional settlement under study. The SwNVI were digitalized with base of orthophoto figures provided by the National Cadastre and Figureping Agency (NCMA 2018); the application Street Figure of Google Earth was also very helpful for localizing the SwNVI. In order to define and delineate the traditional settlements, the residential area compactness was the main criterion.

In order to obtain the appropriate data, the study continues with visibility computation, a common application using geographic information systems (Davidson *et al.*, 1993; Nutsford *et al.*, 2015). Applications of viewshed analysis are numerous and related to landscape assessment and management. Viewshed analysis as such has been the most popular methodology to quantify visibility (Davidson *et al.*, 1993; Nutsford *et al.*, 2015), with numerous applications in a wide range of fields. This methodological approach provides the results of the study, which are analysed and interpreted and, eventually, lead to conclusions.

Materials and Methods

Traditional Settlements and Their Visual Impact on Cyclades

Islands are generally considered particular socio-spatial systems with fragile natural and cultural heritage because, mainly, their small size and isolation (Cross & Nutley, 1999; Spilanis *et al.*, 2009; Spilanis, 2012; Karampela *et al.*, 2014). The main feature of these islands is typical traditional architecture, with small buildings with specific materials and morphology. Their relief is characterized by physical-geographical fragmentation and territorial discontinuity, with arid areas or sparse vegetation. In such a particular landscape, any intervention should be absolutely compatible with the prevailing scale and appropriate forms.

Cyclades is an island complex of the Aegean, consisting of 26 inhabited islands and numerous uninhabited islets, and administratively belongs to the South Aegean region (Figure 1). Most of the islands are characterized by fragmented and mountainous terrain. The permanent population of the Cyclades is of 99,144 people (ELSTAT 2011). The main demographic characteristics are unequal population distribution among islands, population aging and abandonment of the islands by the productive population as well as the intense seasonal population growth (MEECC 2015).

The economy of the islands is based primarily on tourism that is able to provide great profit in a short period of time (Sakellariou *et al.*, 2016; Kizos *et al.*, 2017), thus leading to the abandonment of the primary and secondary production sector (Tsartas, 2003), which – besides the agricultural products – create numerous of the characteristics of the island landscape, terraces, traditional agricultural structures and cobbled streets

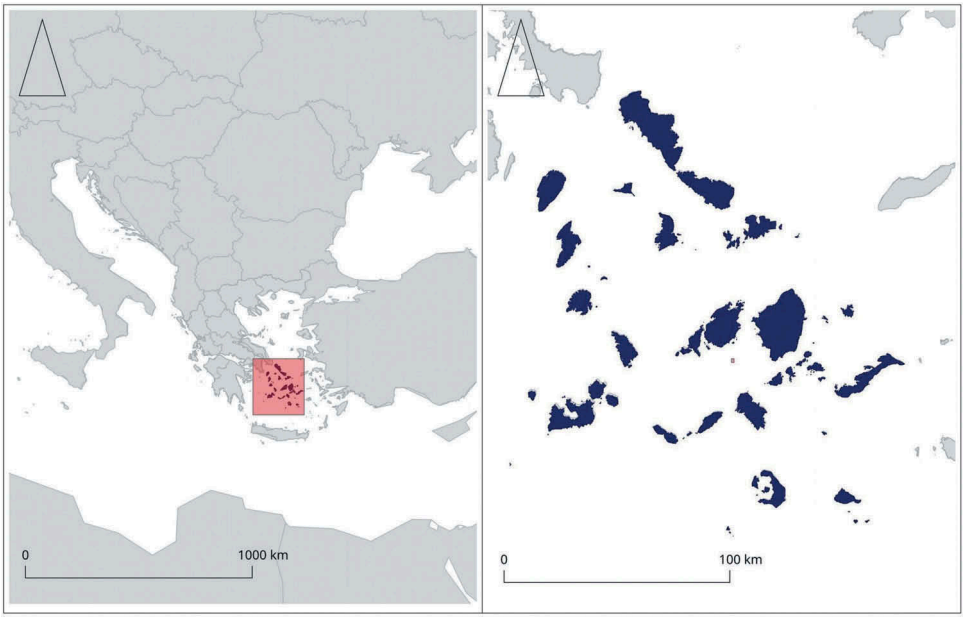


Figure 1. Location Figure of Sifnos island.
Source: authors' analysis

(Kizos & Koulouri, 2005; Petanidou *et al.*, 2008). The islands of the Cyclades face major difficulties with accessibility to social and technical structures (Spilanis *et al.*, 2012; Karampela *et al.*, 2014). Spatial fragmentation, coupled with the absence of a well-developed inter-cycladic transport network, hinders access to health services, education, energy and other basic infrastructures and services.

In Cyclades, there are 169 nominated traditional settlements (OGG, 1978; 1988). The terms and building restrictions for traditional settlements are defined according to Presidential Decree 345/D/89 (OGG 1989). Completions and modifications to terms and restrictions are laid down in Law 3201/2003 (OGG, 2003a). Key issues that the aforementioned Law deals with are: new construction should be in harmony with the prevailing range of traditional settlements, restoration and promotion of human interventions in the landscape should be oriented towards sustainability (paths, terraces, etc.), whereas maintenance and continuity of particular architectural elements (shape, colour, roof type, etc.) can be preserved with the local know-how and with careful and correct use of new materials.

Traditional settlements are not only under pressure due to changes occurring within the residential area but are also affected by changes occurring in their landscape. New structures that serve massive tourism or they are necessary for island residents are often located without appropriate spatial studies. However, most of the time this infrastructure exceeds the local scale and creates negative visual impact.

Data

The choice of structures that are considered here are those that put pressure on the landscape is based on (a) the disruption of the landscape continuity; (b) the incongruity

of the structures with the dominant local scale; (c) their incompatibility with the forms and shapes that are appropriate in the territory; and (d) the unconventional material and construction techniques that are used (Tsilimigkas & Derdemezi, 2017).

We should, however, admit that all 'users' of a landscape may neither have the same perception of it nor evaluate landscape and structures in the same way, thus it is necessary to set some key criteria, a fact that is done in the present work.

According to the above analysis, the selected structures are (Table 1):

(a) **Quarries and Mining areas** (aggregates, marble quarries, industrial mines quarries, mines and shale quarries) do not only extend to a large height but also occupy a large space. Mining is an economically important and widespread activity in Greece. Quarries are opened in hill slopes altering the landscape permanently (Mouflis *et al.*, 2008). The Greek legislative framework for the operation of mines and quarries is set out by Law 1428/1984 (OGG 1984) and has subsequently been revised, amended, and supplemented by Law 2115/1993 (OGG 1993) provisions. These laws have as provision the prohibition of mining activities in areas of outstanding natural beauty and cultural heritage, locations closer to 1 km from inhabited areas or 2 km from nominated archaeological areas, and require that adequate provisions should be made for the protection of the environment and the restoration of the site after it has been exploited, despite the fact the stage of restoration is usually omitted by the provision of Law (Mouflis *et al.*, 2008). It is considered that from a distance of 8 km and more, an observer has a sense of the overall perspective, without being able to discern the details of a landscape (Menegaki & Kaliampakos, 2012). A distance of 7 km is considered maximum for one to have visual contact with a marble quarries (Bishop, 2002). The mean elevation of marble quarries is here approached to 200 m. (Mouflis *et al.*, 2008). Quarries and mining areas have been identified and digitized from the portal of mines and quarries in Greece (MEECC 2008).

(b) **Waste disposal sites** (uncontrolled waste disposal site (UWDS)) ['Choros Anexelegktis Diathesis Apovliton', in Greek] and landfill sites ['Choros Ygeionomikis Tafis Aporrimmaton', in Greek]: The UWDS is not an appropriate alternative of waste disposal because there is no concern for the environment, the waste is burned causing air pollution problems. Landfill sites is a better solution that take into consideration the environmental parameters. The waste is buried using special membranes to avoid soil pollution, the restoration of the area is

Table 1. Visibility distance and height of SwNVI.

SwNVI	Visibility distance (km)	Height (m)	Based on
a	7	200	Law 1428/1984 (OGG, 1984), Law 2115/1993 (OGG, 1993), Menegaki & Kaliampakos, 2012, Mouflis *et al.*, 2008, (MEECC, 2008)
b	7	200	Alexakis & Sarris, 2014, OGG, 2003b, empirical approach
c	4	10	Eskioglou & Stergiadou, 2012, empirical approach
d	7	50	OGG, 2008b, Bishop, 2002, RAE, 2017
e	7	30	Empirical approach
f	3	1	OGG, 2011, Ganias, 2015, empirical approach

Source: authors' analysis

planned. There is plethora of papers that develop arguments and methodologies for their appropriate placement (Gemitzi *et al.*, 2007; Alexakis & Sarris, 2014). The criteria that are taken into consideration based on the Council Directive 1999/31/EC are: (a) the distance from residential areas, waterways, waterbodies and other agricultural or urban sites; (b) the existence of groundwater, coastal water or nature protection zones in the area; (c) geological and hydrogeological conditions in the area; (d) the risk of flooding, subsidence, landslides or avalanches in the site; and (e) the protection of the nature or cultural patrimony of the area (Council of Europe, 1999). An important criterion that should be considered is the visibility at settlements and main roads (Alexakis & Sarris, 2014). Here, the visibility distance for waste disposal sites was chosen according to the visibility distance of quarries and mining areas set in 7 km. The tallest of the three waste disposal sites in the case study area is landfills consisting of steps like quarries. For this reason, it is considered that waste disposal sites have the same height as quarries and mining areas approached to 200 m. The waste disposal sites have been identified based on the figures of the *Regional Framework for Spatial Planning and Sustainable Development of South Aegean Region* (RFSP&SD of South Aegean Region) ['Perifereiako Plaisio Chorotaxikou Schediasmou kai Aeiforou Anaptyxis gia tin perifereia notiou Aigaiou', in Greek] (OGG 2003b).

(c) **Embankments from the opening of roads**: Interconnection within the islands is essential for serving the residents, but as in any other structure the environment and the landscape should be taken into consideration. The abrupt relief and the spatial fragmentation of the Cyclades create both important difficulties with infrastructure construction and significant budget and timetables overruns. Moreover, the low vegetation of islands is unable to cover the embankments that not only create negative visual impact but also increase the risk for sliding (Eskioglou & Stergiadou, 2012). Since embankments are shorter than quarries, the visibility distance is reduced in the half, that is, is set in 4 km. It is considered that the height of embankments correspond to one step of quarries which here approach 10 m. The embankments have been identified and digitized from the Street Figure application of Google Earth.

(d) **Wind turbines**: The placement of wind turbines is identified by the *Special Framework for Spatial Planning and Sustainable Development for the Renewable Energy Resources and the Strategic Environmental Impact Assessment* (SFSP&SD for RER) ['Eidiko Plaisio Chorotaxikou Schediasmou kai Aeiforou Anaptyxis gia tis Anenosimes Piges Energeias kai tis stratigikis meletis perivallontikon epiptoseon aftou', in Greek] (OGG 2008b). The Aegean islands have a great potential of wind power, and the installation of wind turbines on land and at sea is promoted (Tsilimigkas *et al.*, 2018). However, the RER can both drive to landscape and environmental degradation (OGG, 2008b) and have serious social impact (Maslov *et al.*, 2017; Yu *et al.*, 2017). The placement of wind turbines on peaks and ridges and their size on the arid ground of islands make the integration of wind turbines in the landscape difficult. Unlike the quarries and mining areas, wind turbines are not as bulky as tall. Here, the visibility distance is set in 7 km (Bishop, 2002). Wind turbines have various heights according to their technical characteristics. The average height of the tower of the wind turbine places in Cyclades wind parks is 50 m. (RAE 2017) For

the identification of wind turbines, the geoportal of Regularity Authority of Energy (RAE, 2017) was used.

(e) **Mobile phone antennas**: The technological development and the ever-increasing use of mobile phones have made the mobile phone antennas necessary everywhere. Apart from the impact on human health that has been widely discussed (Briggs *et al*., 2012), there are concerns for their negative visual impact too, since antennas are a similar case to wind turbines. Mobile phone antennas are thinner than wind turbines but they still tall enough, so the visibility distance is set in 7 km. Their height is varied but in Cyclades most of them are about 30 m. For the identification of mobile phone antennas, the Figure of the Greek Atomic Energy Commission was used.

(f) **Aquaculture**: According to Special Framework for Spatial Planning and Sustainable Development for Aquaculture (SFSP&SD) ['Eidiko Plaisio Chorotaxikou Schediasmou kai Aeiforou Anaptyxis kai tis stratigikis meletis perivallontikon epiptoseon aftou', in Greek] (OGG 2011), aquaculture is a very important economic activity, and Greece has advantage in this sector. However, aquaculture raises environmental and hygiene issues, and can be in conflict with other activities (Chatziefstathiou *et al*., 2005). An issue that can be conflictual is the visual impact that aquaculture has on other activities like tourism. In Cyclades, there are only fish farms in cages. Aquaculture is the only under study structure that is placed on marine surface, a marine space that has different characteristics, such as a smooth surface. We chose the visibility distance based both on this parameter and on the fact that fisheries are low structures that usually occupy a large marine area. The visibility distance here is set in 3 km. The fish farm cages have height 1 m or less and depth 6–9 m (Ganias, 2015). For the identification and digitalization of aquaculture was used Google Earth.

Having said that, we should mention that during our research the major problem we faced was that the delineation of traditional settlements is not provided in open access digital format for all the settlements under study, so we had to identify and digitize the nominated traditional settlements, since we did not have their limits in digital format (OGG, 1978; 1988). The methodological approach that we followed for their digitalization is based on the compactness of the built-up area patches. The basic typology we followed is the compact residential areas of the traditional settlements. However, sprawl has altered the shape of the residential area with new constructions around the settlements, along the nearby roads and intense spreading to all directions of the coastal areas. In the present paper, we digitized the traditional settlements by including only the compact residential area and not the recent residential extensions. That has been a challenge due to the fact it is often inconspicuous what constitutes a newer residential extension. However, by adopting the same methodological approach for all settlements for which we did not have their limits in digital format, we ensured the consistency of the results of the methodology as described and discussed below.

Methods

In this study, viewshed analysis has been adopted here, since it has been used in a wide range of studies. This method has been used because it determines the visibility of pixels across a surface from selected viewpoints. Several researchers (both Greek and international) have used viewshed analysis for various issues in Greece, some representative cases of which are briefly presented.

Viewshed analysis was used so the decreased visibility towards the sea and in fragmentation of the initial landscape could be studied. The study carried out a chronological visibility analysis from 1981 to 2002 for the coastal tourist landscape of Kefalos on Kos island, and was based on the spatial distribution of land use patterns, the evolution of a complex system of transport networks and the increased building density (Gkoltsiou *et al.*, 2013). Another instance where viewshed analysis was used was when the visibility of wind turbines in South Aegean Region as a pressure factor for the island landscape was studied (Tsilimigkas *et al.*, 2018). The study result was the percentage of the total island area and the percentage of the population that has visibility at wind turbines. Viewshed analysis was also used in order so that the visual impact of the marble quarries on Thasos island could be studied. The quarries cause disruption to the landscape continuity and are generally considered as landscape degradation factors. Mouflis *et al.* (2008) carried out a study and showed the increase of visual impact caused by marble quarries for the period from 1984 to 2000 in quantitative terms (Mouflis *et al.*, 2008). Furthermore, viewshed analysis is often used so that visual impact focusing on settlements can be studied. In the study by Sevenant and Antrop, the visibility of Paros island and Lasithi (Crete island) in certain land use is quantified, being based on two different distance zones (Sevenant & Antrop, 2007). Finally, another case is the study of the visibility for the Sifnos island settlements by Tsilimigkas and Derdemezi, so that arguments for the importance of spatial planning in landscape management could be raised and developed (Tsilimigkas & Derdemezi, 2017).

At an international level there is also a plethora of studies that use the viewshed analysis, indicatively: Viewshed analysis was used in order to be determined non-built-up area with sea view in a coastal area near the city Mersin in Turkey (Alphan & Sonmez, 2015). Robert (2018) used viewshed analysis as a tool for spatial planning, in order to give information about particular coastal landscapes of southern France. Depellegrin (2016) carried out a study for existing and planned sea uses that could lead to negative visual impacts of the Baltic Sea landscape. In the study by Falconer *et al.* (2013) the visual impact of aquaculture in Western Isles located off the North West coast of Scotland is attempted to be evaluated.

There are other several more methods available for the quantitative analysis of visibility such as isovist which measures the volumetric visibility. Isovist is the set of all points visible from a given vantage point in space and with respect to an environment (Benedict, 1979). It is suggested both as a tool to study behaviour and perception in space (Wienner & Franz, 2004; Dosen & Ostwald, 2017; Sedlmeir & Feld, 2018) and as a tool to identify architectural or urban planning patterns (Batty, 2001; Turner *et al.*, 2001; Turner, 2003). The spatial openness index is a quantitative index, based on a three-dimensional visual analysis of space and rendered as 3D isovist (Fisher-Gewirtzman *et al.*, 2003). However, according to Fisher-Gewirtzman *et al.* (2013), these indexes are unable to model complex 3D objects, such as buildings, in short time and accurately.

Thus, they propose the urban environment volume be subdivided into voxels (Fisher-Gewirtzman *et al.*, 2013). The volumetric visibility analysis that is based on voxels calculates the visible volume of space to reflect human visibility and the perceived density (Fisher-Gewirtzman *et al.*, 2013).

The research questions that these indexes attempt to manage and the scale they are applied to are irrelevant to the present study. From the aforementioned brief literature review comes out that viewshed analysis is the most appropriate method for the purpose of this study.

Implementations of the Method of Viewshed Analysis

Should the aforementioned cases be taken into consideration, then viewshed analysis is the most appropriate method to study the visual impact of SwNVI on traditional settlements receive from the structures. In more detail. 'Visibility' depends both on the terrain and the size characteristics of observers and targets. Visibility distance, apart from their dimensions and volume, is based on: visual thresholds estimation, visual contrast and effects of the atmospheric dispersion of colour (Bishop, 2002). Here, for the terrain model, the Aster DEM with 30 × 30-m cell size was used (METI and NASA 2011). The observer height was set in 1.75m. (as an average height), whereas the height of the target and the distance of visibility change accordingly the infrastructure, as presented in 2.1 of the present study.

Results

Figure 2 depicts the areas of Cyclades islands that have view to each one of the six categories here considered as the SwNVI (Table 2). The total study area occupies 2609 km^2, while the total area is occupied by traditional settlements is 33.4 km^2.

Figure 2(a) **Waste disposal sites** are visible at 491 km^2, which means approximately 19% of the total island area, while 7.33 km^2, which means approximately 22% of the area of traditional settlements has visibility to them. Although visibility rates are not particularly high, waste disposal areas are likely to bring about the strongest pressure on the landscape.

Figure 2(b) **Mines and quarries** are visible at 1268 km^2, which means approximately 49% of the total island area, while 19.64 km^2, which means approximately 59% of the area of traditional settlements has visibility to them. Mines and quarries occupy large areas and disrupt the landscape continuity, many of them have been in the specific locations for several decades, but new locations should take account of visibility and care for restoration as long as they are not in operation.

Figure 2(c) **Embankments** are visible at 1098 km^2, which means approximately 42% of the total island area, while 18.7 km^2, which means approximately 56% of the area of traditional settlements has visibility to them. The percentage is particularly high due to islands' abrupt relief. The intense slopes combined with the low vegetation does not help to landscape smooth recovery after the road construction.

Figure 2(d) **Wind turbines** are visible at 327 km^2, which means approximately 13% of the total island area, while 5.6 km^2, which means approximately 17% of the area of the traditional settlements has visibility in some of them. Wind turbines are a form of

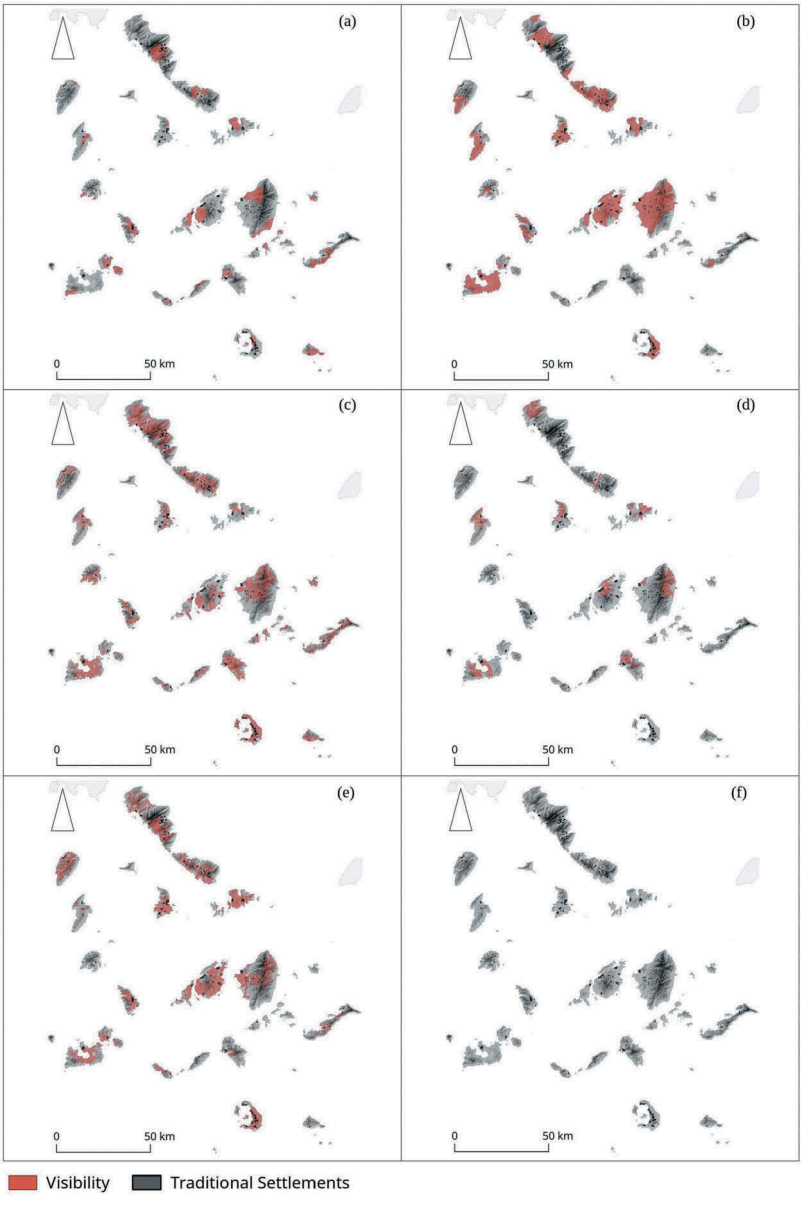


Figure 2. Areas with visibility in SwNVI.
Source: authors' analysis

renewable energy source with great environmental benefits, but the size of the wind turbines exceeds the prevailing scale of the islands and puts pressure on the landscape as well as drives in reactions from the local societies.

Figure 2(e) **Mobile telephone antennas** are visible at 964 km^2, which means approximately 37% of the total island area, while 22.4 km^2 – which means approximately 67.1% of the area of traditional settlements – has visibility on a mobile phone antenna. The high visibility of traditional settlements on a mobile phone antenna is justified because many

Table 2. Areas with visibility in SwNVI.

	Total island area		Traditional settlements	
SwNVI	km^2	%	km^2	%
a	491	19	7.33	22
b	1268	49	19.64	59
c	1098	42	18.7	56
d	327	13	5.6	17
e	964	37	22.4	67.1
f	0.571	0	-	-

Source: authors' analysis

of them have during tourist period important number of tourist and population, which creates significant demand for mobile phone services that drive in antennas' placement in proximity. Undoubtedly, their uncontrolled placement creates pressure on the island landscape and drives in reactions from the local societies.

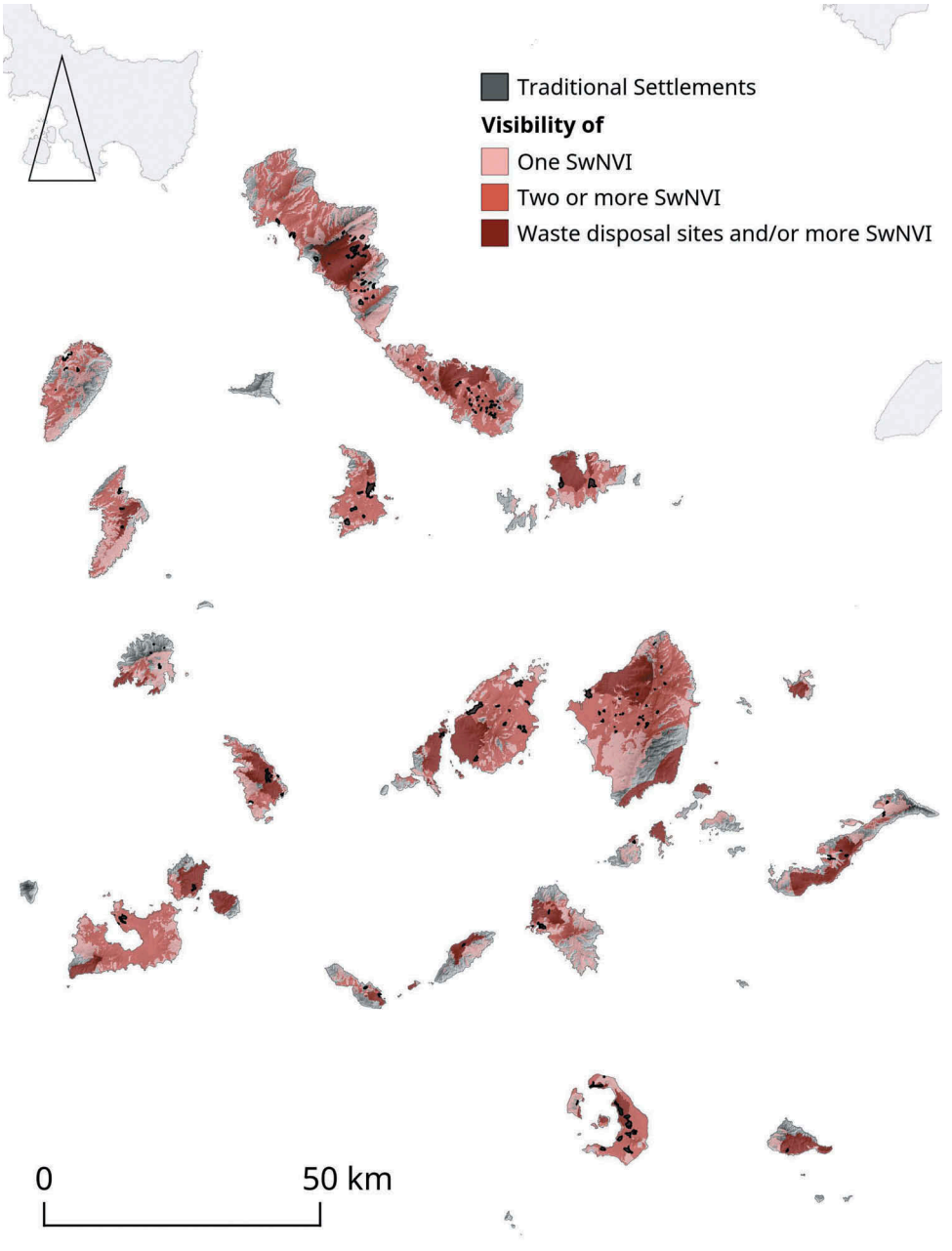
Figure 2(f) **Fisheries (Aquaculture)** are (is) visible at 0.571 km^2, which means approximately 0% of the total island area, while there is not visibility of traditional settlements at aquacultures. As it seems aquaculture has limited effect on the landscape of the Cyclades. Aquaculture is an activity that is constantly developing and the understudy island complex has advantage, so attention should be paid to future placements.

For the overlay Figure (Figure 3. Major categories of areas with visibility in SwNVI), the six layers (Figure 2 Areas with visibility in SwNVI) was crossed and classified in four categories based on the number of different types of SwNVI that are visible from traditional settlements, and on the degree of pressure in the landscape (the waste disposal sites was considered to be the most an important factor of visual degradation). The overlay Figure (Figure 3) group 4 major categories of visual impact: (a) areas without visibility in SwNVI, (b) areas with visibility in one category of SwNVI except from waste disposal sites, (c) areas with visibility in two or more categories of SwNVI except from waste disposal sites and (d) areas with visibility in waste disposal sites, possibly also in other categories of SwNVI.

From the above analysis comes out that 675.52 km^2, which means approximately 26% of the total area, has visibility in one category of SwNVI, while 5.4 km^2, which means approximately 16% of the area of traditional settlements, has visibility in one category of SwNVI. 917.86 km^2, which means approximately 35% of the total area, has visibility in two or more categories of SwNVI, while 18.97 km^2, which means approximately 57% of the area of the traditional settlements, has visibility in two or more categories of SwNVI. 491 km^2, which means approximately 19% of the total area has visibility at a waste disposal site, possibly in other types of SwNVI, while 7.33 km^2, which means approximately 22% of the area of traditional settlements, has visibility at a waste disposal site, possibly in other categories of SwNVI. (Table 3).

Discussion and Conclusions

Cyclades are characterized by a distinct and fragile natural and cultural heritage, on which pressure is exerted by development. The Islands peculiar geography means their small size, their great dispersion and their peripheral position according to the poles and development axes, are the main development factors to be taken into consideration in



planning. The islands' built-up environment has been formed according to natural and human-induced factors that are influenced by endogenous and exogenous dynamics as they occurred through historical conjunctures and political choices. Nowadays, tourism is the dominant economic activity on the islands in various forms, especially as mass tourism is concentrated during the summer season. Massive tourism, in conjunction with

Table 3. Major categories of areas with visibility in SwNVI.

	Total island area		Traditional settlements	
SwNVI	km^2	%	km^2	%
a	524.62	20	1.7	5
b	675.52	26	5.4	16
c	917.86	35	18.97	57
d	491	19	7.33	22

Source: authors' analysis

the loose application of an integrated spatial planning framework for the islands, puts an extra pressure on traditional settlements and the islands' landscape. It concerns a development mode that exceeds the carrying capacity of local socio-spatial systems because of its intense and massive character and, particularly because the pressure it exerts on traditional productive activities are primarily associated with agricultural cultivation.

The present research has studied structures that are inherent with the development model but cannot be incorporated successfully in the island landscape. It concerns both structures that disrupt landscape continuity, are incongruous with the dominant local scale and incompatible with the forms and shapes that are appropriate in the territory, and the material and construction techniques that are unconventional. The SwNVI often affects a larger percentage of traditional settlements compared to the percentage that affect the total area of the islands. This shows, that visibility criteria have not been taken into consideration before the placement of structures. Within this context, it should be underlined that the model of development and the loose application of spatial planning framework are the main causes of the pressures put on landscape of traditional settlements.

Although the multisectoral, multidimensional and multi-scale character of the landscape is acknowledged in the present study, their analysis is considered beyond the aims of the study. Despite it focuses on specific landscape issues emerging at a local scale because of its holistic character, these issues affect both the material and immaterial dimension. A significant dimension that should be taken into consideration for the proper protection and management of the landscape is the height of structures. More specifically, for areas like Cyclades islands that have such a distinct scale both of human made construction (buildings, alleys, etc.) and natural features (low flora), the height of new structures should comply with the dominant scale.

For many decades and despite efforts made before the enactment of Law 3827/2010 (OGG, 2010), two principal characteristics dominated and discouraged landscape protection. First, there was a large number of institutional tools for landscape protection, through statutory arrangements that were supporting certain *ad hoc* landscape qualities. Second, sectoral policies —such as policies on tourism, transportation and energy— are pronounced and implemented with a significant impact on landscape. These policies do not ensure coherence within any spatial framework and do not prioritize landscape.

Although the importance of traditional settlements is acknowledged at international, European and local level, there is no consistent policy in Greece that aims at their proper management and protection; that means, a spatial planning framework that can ensure sustainable development of the islands and the protection, promotion and proper management of their cultural and natural heritage. Instead, the protection and

management of traditional settlements have been the responsibility of many, different authorities, which has resulted in overlaps and inability to implement institutional frameworks and urban planning provisions (Tsilimigkas *et al.*, 2015).

Furthermore, in this study, we have tried and quantified the visual impact on the traditional settlements of Cyclades that come from structures which, within the present context, are considered as main causes creating and exerting pressure on the island landscape using visibility computation, a very common application using Geographic Information Systems. Nevertheless, despite the undoubtedly numerous applications of the method, visibility analysis cannot be considered sufficient in itself to cover a complex and multidimensional issue such as landscape assessment, since particular issues of the material and immaterial dimension emerge. We believe that the methodology we have proposed is useful for spatial planning, so that an up-to-date list of all the necessary quantitative data on traditional settlements can be created and thus not only the current situation but also the future investment in landscape impact can be assessed.

The quantitative result of visibility analysis demonstrate that the negative visual impact on traditional settlements of Cyclades is not negligible. The SwNVI are able to put pressure on the landscape of traditional settlements on both material and immaterial dimension. Such indexes should be taken into consideration by the regulatory spatial planning. Specifically, the index of visibility analysis could be a useful tool for the local spatial plans (LSP) as they defined by the Law 4447/2016 'Spatial planning – sustainable development and other provisions' (OGG 2016). The LSPs regulate the sustainable spatial development and organization of the territorial area of a local administrative unit 1 (LAU1), and for local administrative unit 2 (LAU2), categories of areas which underlie specific regulations: residential areas, areas of productive or business activities, protected areas, and areas where the land uses are critical. The index of SwNVI, as presented here, could support the decision-making of these areas and would incorporate the landscape aspect in regulatory spatial planning.

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