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'What do you see in the landscape?': visibility analysis in the island landscape of Sifnos, Greece

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ABSTRACT: This paper attempts to quantify the visual impact that certain infrastructures and buildings have on Sifnos island, a small island located in the southwestern Cyclades. Quantification of the visual effects is based on the viewshed analysis through GIS. The main element of the visibility computation method, as adopted here, is the identification of those infrastructures and buildings that are considered actors with a 'negative' impact on the landscape. The analysis demonstrates that zones with varying impact on landscape can be identified. Investments with 'negative' impact on the landscape should be directed towards areas of restricted visibility, thus minimising landscape degradation.

Keywords: Greece, islands, landscape, Sifnos, visibility analysis

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1. Introduction

In this paper, we attempt to shed light on some aspects of the complex relationships between tourism and landscape management and planning on islands with the use of visibility analysis techniques.

Islands are commonly seen as complex and fragile socio-spatial systems with important potential, and are the focus of numerous innovative studies (Baldacchino, 2004, 2006). Although islands are described by their heterogeneity of certain parameters—such as population, proximity, location, dominant economic activities, cultural differences, and the exploitation of local resources (Karampela et al., 2014) —they also share certain notable features that allow their identity to be considered as a whole. Insularity creates delicate but unique ecosystems, and vulnerable economies, generally with a significant dependence on tourism (Tsartas, 2013; Karampela et al., 2014; Spilanis et al., 2012, 2008). They are also seen as territories with potential for economic growth, in activities such as energy conversions and underwater resources, and particularly as attractive places for tourist activities. This wide range of activities from which islands can benefit can almost certainly create land use conflicts and put significant pressure on natural and cultural heritage, and landscape qualities (CEMAT, 2000).

Within this context, this paper aims to shed light on specific landscape issues emerging at a local scale. Sifnos, a small island located in the southwestern Cyclades, was chosen as a case study. The main question in the paper involves how to quantify the visual impact of Sifnos island, which is mostly the result of unplanned and very often unregulated, building and infrastructure construction in exurban insular areas, and is based on visibility computation. In other words, we use a quantitative method to assess visibility in a tourism landscape.

2. Landscape studies

We will first briefly present the background of landscape studies exploring tourism and landscape, with a focus on islands. Landscape studies are trans-disciplinary and multi-sectoral approaches (Tress et al., 2003), including disciplines as diverse as landscape ecology, geomorphology, human geography, cultural geography (Antrop, 2006). This is considered a requirement due to landscape's complexity and its dynamic character, which consists of a constant interaction between its material and immaterial nature (Detsis et al., 2010; Bürgi et. al., 2005). The material nature of the landscape is a result of the osmosis of the physico-geographical characteristics of an area, and human-made structures (Howard, 2011). The immaterial nature of the landscape involves the relationship that people develop with the area they live in, at both an individual and collective level (Jakob, 2008).

Within this framework, the European Landscape Convention (ELC), reflecting the priorities of the Council of Europe, has acknowledged that landscape is "an important part of the quality of life for people everywhere: in urban areas and in the countryside, in degraded areas as well as in areas of high quality, in areas recognised as being of outstanding beauty as well as everyday areas". It is also reported that landscape values have an "important public interest role in the cultural, ecological, environmental and social fields" and encourages the incorporation of landscape parameters into spatial planning procedures in order to "promote the protection, management and planning of European landscapes and organize European co-operation on landscape issues" (Council of Europe, 2000). The ELC was adopted by nineteen countries, including Greece, in Florence on 20 October 2000. It took the Greek government ten years from the adoption date to ratify the ELC in the national legislative system, given, on the one hand, the non-binding nature of the convention and, on the other hand, ative rigidities, bureaucracy, and different political priorities (Vlantou, 2010, 2012). Despite the significant time lag, Law 3827/2010 "on the ratification of the ELC" (GOG, 2010) is indisputably a positive step towards sustainable development and landscape management, upon which considerable pressure has been put (Tsilimigkas et al., 2015).

Tourism as an economic and social practice is related to landscapes and their appreciation in many ways. Tourists seek 'iconic', 'popular', 'relaxing' landscapes, for example, and plan trips and vacations according to real or imaginary landscapes, mostly in its alternative forms. The so-called 'tourist gaze' has therefore shaped many landscapes and is considered very important in tourist destinations (Urry, 1996 ; Urry & Larrsen, 2011). What tourists 'see' in a destination and how this relates to their expectations (real or imaginary), and what they consider 'beautiful' or 'tolerable', is a critical parameter. In this sense, what is visible in a tourist destination may be very important for the tourism industry, and may shape the economic fortune of the destination.

Although we may be very specific about what we like and what we do not, what we want to see and what we do not, few people base all their decisions and their behaviours exclusively on this. In fact, most people tend to ignore sights and issues that may bother or disturb them. This is certainly true for tourists. Although many tourists clearly see landscapes, sights, and buildings that they do not like, these may be overshadowed by other aspects of the appearance of a destination. This, of course, does not mean that they are willing to forgive everything, especially now that the power of images, views, and landscapes is growing due to the rising importance of social media and the ability of tourists to depict what they do/don't like and share it with the rest of the world.

This increases the importance of what is visible and the need to carefully plan for land uses that are unpopular, ‘ugly’, or simply do not conform to what tourists expect to see and experience.

An important area in the interface between islands and landscapes is tourism. Tourism is very important for islands economically, socially, and symbolically, and it also has an important impact on development issues (Spilanis et al., 2008). Tourism is one of the most important activities for the economy of islands, in terms of employment and income. It also has a significant effect on local societies, lifestyles, and quality of life, both ‘positively’ and ‘negatively’ (Karampela et al. 2016). Symbolically, islands and their landscapes have shaped tourist preferences but have also been shaped by them.

3. Overview of Sifnos

In this paper, we use a quantitative method to assess visibility in the tourism landscape and shed light on specific landscape issues emerging at a local scale on Sifnos, a small island in the southwestern Cyclades, Greece. Administratively, Sifnos belongs to the South Aegean region (Figure 1). Its municipality covers 77.2 km², and has a coastline that extends approximately 70 km. It is a rocky, hilly island traversed by four parallel mountain ranges, which include two high peaks: Prophet Elias (682m) and Agios Simeon (463m) in the north of the island. The small islet Kitriani is located to the south of the island. Island vegetation is typically Mediterranean, consisting principally of shrubs (frygana and herbs). The western part of the island—Mt Prophet Elias—and the western coast and part of the sea area are denominated as Natura 2000–protected areas because of their natural value, with Juniperus, olive groves, and carob extended areas and Posidonia fields.

Despite the fact that annual rainfall in the Cyclades is low—which favours neither the formation of underground aquifers across the islands nor the appearance of surface water— Sifnos has a rich underground aquifer. The lack of long-term water management and over-pumping for agricultural production and tourist activities has generated a shortage of water resources, however, which primarily emerged in the past decade.

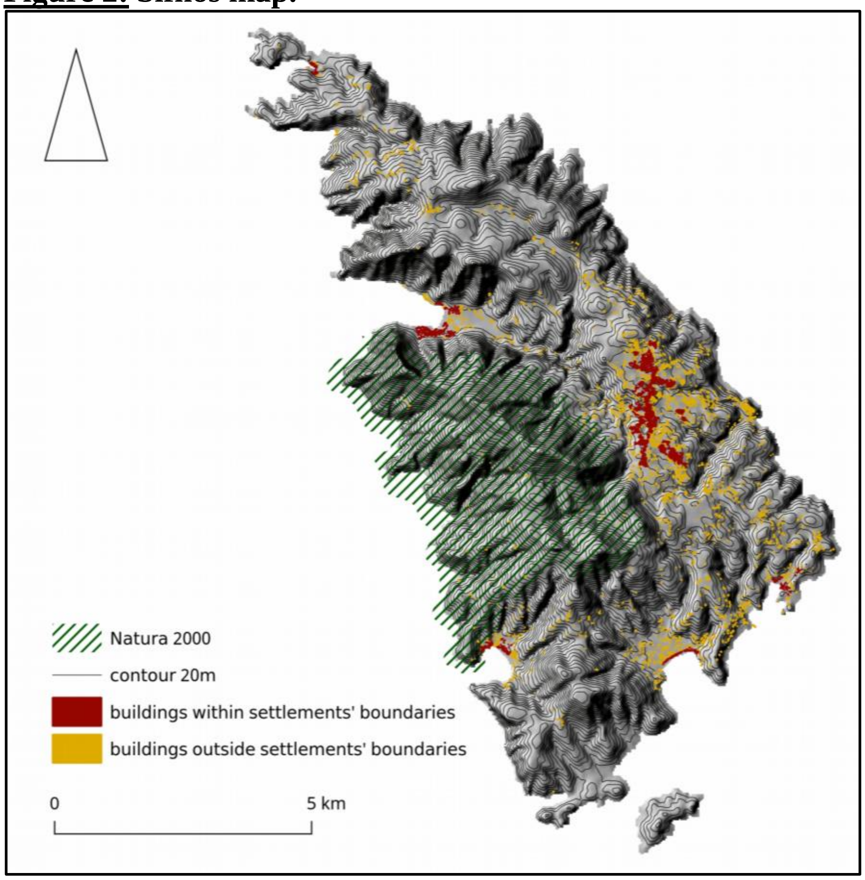
<u>Figure 1:</u> Location map for Sifnos island.

Source: © 2017 Tsilmigkas & Derdemezi.

The island has a total of sixteen villages and settlements (Apollonia, Pano Petali, Artemonas, Agios Loukas, Exampela, Katavati, Kato Petali, Agia Marina, Kamares, Kastro, Faros, Platys Gialos, Bathy, Xeronisos, Troulaki, Chrysopigi). Troulaki and Chrysopigi are small residential clusters without carved limits, and Kastro has no carved limits as it is part of the jurisdiction of the 'B' Ephorate of Byzantine Antiquities' ('B' Ephoreia Byzantinov Arxaiotiton', in Greek) (Figure 2). According to the 2011 census, the permanent population of the island is 2,625 people (ELSTAT, 2001). It is worth noting that during the summer months, for the approximately 140 days which are considered the summer season on the island, the population increases significantly. The average total population of the island (tourists and residents) increases to 10,000 and may reach 15,000 on peak days, especially in August.

The principal employment sector on Sifnos island is the tertiary sector, mainly the hospitality industry, with farming and agricultural activities showing a significant decline in recent years. The production base of the island has been changing greatly over the last ten years towards tertiarisation. In the 2001 census (ELSTAT, 2001), 17% of the population was engaged in the primary production sector, 33.14% in the secondary sector, and 49.77% in the tertiary, whereas, according to the 2011 census (ELSTAT, 2011), only 8.2% of the population engaged in the primary sector, 28.16% in the secondary sector, and 63.64% in the tertiary sector. This is a trend in employment towards services, especially those related to the hospitality industry, causing a decline of the primary sector, which has been the key productive activity for the island, and it has important effects on the natural environment and landscape qualities as well as on social cohesion.

Figure 2: Sifnos map.



Source: © 2017 Tsilmigkas & Derdemezi.

4. Data

The main question involves how to quantify the visual impact of Sifnos, which is mostly the result of unplanned and very often unregulated, building and infrastructure construction in exurban insular areas, and is based on visibility computation. In other words, we use a quantitative method for assessing visibility in a tourism landscape. The method used is one of many alternative methods, and can be complemented by other less quantitative and more participatory methods. We believe that it is a valuable addition to the arsenal of landscape planning methods, especially for islands.

Visibility computation is a very common application using Geographic Information Systems (Davidson et al. 1993, Nutsford et al., 2015). The applications of viewshed analysis are numerous and related to landscape assessment and management. It has been demonstrated as the most popular methodology for quantifying visibility (Davidson et al. 1993; Nutsford et al., 2015), with numerous applications for a wide range of fields, including archaeology and cultural heritage objects (Chapman, 2006; Ogburn, 2006; Wheatley & Gillings, 2000), forestry and general vegetation issues (Domingo-Santos & de Villara 2011; Llobera, 2007), and impact assessment and land compensation (Lake et al. 2000; Howes & Gatrell, 1993). It is also particularly relevant to planning facility locations and managing environmental resources (O'Sullivan & Turner, 2001; Mouflis et al., 2008). 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 analysis, since particular issues of the material and immaterial dimension emerge (Kizos, 2008; Tsilimigkas & Kizos, 2014).

The viewshed analysis has several limitations as regards measuring visibility from a human perspective. Among other things, it is heavily influenced by factors such as (a) the distance between a perceived object and the observer, a factor that determines the relative size of the object; (b) light, atmospheric conditions, and the clarity of the atmosphere; and (c) the vertical dimension (i.e., slope and aspect) of terrain (Nutsford, 2015). Many methods have been developed in response to some of these factors. Many methods have been developed to overcome some of these shortcomings. In other words, although visibility analysis per se is a necessary prerequisite, it is insufficient in itself to be a basis for planning, design, and public policy (Ervin & Steinitz 2003).

Determining the working scale is an important task. Two issues are taken into consideration, the main study question and the availability of datasets. The working scale in this study is fixed at 1:20,000, and, therefore, the spatial resolution of the dataset—namely the dimension of the cell size representing the area covered on the ground—is set at 20*20 m. (Waldo, 1988). The working scale is considered (a) appropriate according to the nature of the paper's question; (b) as a typical scale for physical planning studies; and (c) according to data availability, since there is no open access dataset of higher resolution available.

The datasets that support landscape visibility computation on Sifnos island are the following:

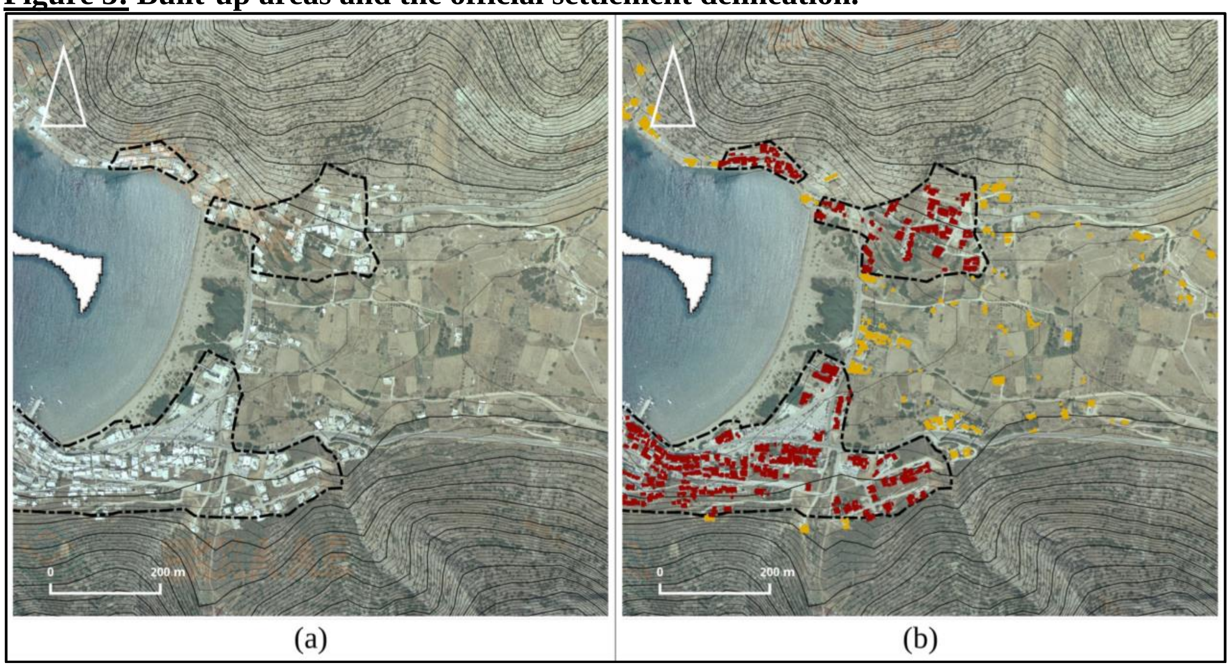
(a) The EU-Digital Elevation Model (EU-DEM) dataset of Greece is used to provide elevation and slope parameters, thus precisely determining the island relief. Data is derived from the EEA (2000), GMES RDA project, and re-projected to the GGRS87 reference system. It is worth mentioning here that an open access DEM of significantly higher resolution, which could be very useful for this kind of study, is not available in Greece.

(b) The institutionalised limits of Sifnos settlements were an important dataset, but not easy to build. The first task concerned the collection of the five different Greek Official Gazettes (GOG) in 'paper format'. These served as the settlement limits description. They are officially provided by the GOG and describe the limits of each settlement in a way that is not always easy (or possible in some cases) to interpret, and very often in diagrams. The diagrams were then scanned in high resolution and projected into the HGRS87 reference system, using the orthophoto maps provided by the National Cadastre and Mapping Agency (NCMA, 2014) as base maps. The official limits of the settlements (which do not usually coincide with the 'real' limits of the settlements) were then digitised with the greatest possible accuracy. The working scale of this procedure is 1:5,000, but there are doubts in many cases, due to the extract quality of the GOG diagrams, about the description of settlement limits.

(c) The geospatial data related to the built-up areas was also created, because there are no appropriate datasets at the national level. Alternatively, in order for the built-up areas to be identified, the Soil Sealing SL geospatial datasets could be used; these geospatial datasets have been produced as part of the Global Monitoring for Environment and Security as a Fast Track Service on Land Monitoring (EEA, 2014). The main deliverable was raster data layer of the continuous degree of soil sealing in full spatial resolution (20*20m). The soil sealing raster layer contains continuous values ranging from 0 to 100% of cover, representing different degrees of soil sealing, namely the impervious surfaces from artificial structures. Here, we consider that the data raises important issues of accuracy, and, therefore, that they are not suitable for the study question (Maucha et al., 2010).

To identify built-up areas, the buildings were digitised from the orthophoto maps provided by the NCMA. This is considered an appropriate source, as the web service offers viewing services in orthophotos with a ground sampling distance (GSD) of 50 cm for the whole country, and fully orthorectified orthophotos with GSD 20cm for urban/built-up areas of the country (NCMA, 2014). The accuracy of the datasets was considered more than sufficient for the paper question. In many cases, there was difficulty in distinguishing between built-up and soil sealed areas but non-built-up areas, so further study in more detail was needed, and an additional field visit was required. Generally, the cells that are presented as a white roof in the orthophoto maps were considered to be built-up areas (NCMA, 2014), but because not all the roofs of the island are white, we also digitised traces of brown or grey that had roof shapes (Figure 3). The working scale for this task was 1: 1000.

<u>Figure 3:</u> Built-up areas and the official settlement delineation.



Source: © 2017 Tsilmigkas & Derdemezi.

(d) The last dataset used to build the visibility analysis included the structures considered to have a 'negative' visual impact. Structures with 'Negative' Visual Impact (SwNVI) for Sifnos island are the following: (i) the uncontrolled waste disposal site ('Xoros Anekselegktis Diathesis Apovliton (XADA)', in Greek); (ii) the factory of the Public Power Corporation ('Dimosia Epixeirisi Hlektrismoy (DEH)', in Greek); (iii) public parking spaces; (iv) mobile telephone antennas; (v) quarries and aggregates quarries; (vi) embankments in slopes due to roads cuts; and (vii) buildings that are incompatible with the prevailing traditional architecture. These structures have been identified in the orthophoto maps provided by the National Cadastre and Mapping Agency (2014). To locate them―apart from the field research and the photographs that were taken―the Google Earth application 'Street Map' proved particularly helpful. The working scale to implement this task was 1: 1000.

5. Methods

The methodology adopted here is based on viewshed map analysis so that the categories of the spatial typologies are defined according to the degree of the area exposure to visual contact with the SwNVI. Visibility computation is chosen as pertinent in the present study because visibility issues are of particular importance for areas where the infrastructure for their development is likely to have a 'negative' impact on qualitative landscapes (Sander & Manson, 2007). A 'negative' visual impact (or landscape disturbance) is part of aesthetic pollution, and is difficult to quantify, since it is fundamentally subjective in nature. Briefly, 'negative impact' can be defined as "any unwanted spectacle mentally or physically affecting the community or creates a risk to health. It refers to all structures that the community finds not attractive e.g. poorly maintained buildings, signs, phone masts, uncontrolled waste disposal site, etc." (Muthukrishnan, 2003). Here, 'negative' visual impact involves unpleasant aesthetics caused by the view of a structure which (a) produces disruption of the landscape continuity; (b) is incongruous as to the dominant local scale; and (c) is considered incompatible with the forms and shapes that are appropriate in the territory. We should, however, admit that all 'users' of a landscape may not have the same perception of it, and may not evaluate landscape and structures in the same way, thus some key criteria are identified in the present work. The procedure followed can be described in three steps:

(1) The first step involves the viewshed map that depicts visual contact with each of the SwNVI. To understand this approach, we can imagine a headlight illuminating portions of a landscape. As the headlight revolves around a viewer's position in the illuminated areas, connected sites can be visually identified. Shadowed areas identify locations that cannot be seen by the viewer and the result is a 'viewshed map'. In this step, the following additional issues were taken into consideration: (i) the tree canopy that blocks visual connections between areas, by creating a visual barrier on top of the terrain. This does not have any meaning here since the island is rocky, with very low brushwood vegetation; (ii) the viewer's height that is fixed at 1.75m, as a typical convention; (iii) the view angle that does not have any meaning here, since we are interested in a panoramic view (360^{o}); and (iv) the distance that is fixed for each individual SwNVI, according to the information given below.

More specifically, defining the maximum distance that visual contact can be maintained with each SwNVI is a critical issue, with important effects on the results, and there is no clear and objective answer, since numerous parameters must be taken into consideration, including, among others, the size of the structure; the concentration of structures; clarity and the general condition of the atmosphere; the observer's age; the year, date, and time; and the user's perceptions. To conclude, the distance of visibility is related to the overall structure characteristics, and, for this reason, it is determined for each SwNVI respectively, mostly using the empirical approach that was based on the responses of locals. More specifically, for the factory of the public power corporation (DEH), the mobile phone antennas, and the buildings that are incompatible with the prevailing traditional architecture, maximum visibility distance is set at 3 km. For the embankments due to road cuts and public parking spaces, the maximum visibility distance is set to 4 km. For quarries, aggregates quarries, and the uncontrolled waste disposal site (XADA), the maximum visibility distance is set to 8 km (Menegaki & Kaliampakos, 2012).

(2) A typical viewshed map requires pixels that are the 'targets', where these are the SwNVI; and pixels as 'observers', namely those who are interested in determining what they see and what they do not. Here, we are interested in viewing the visual contact with each SwNVI of the whole area of the island, and not only for certain pixels of interest. To that end, 'observers' and 'targets' are reversed. We set the SwNVI as 'observers' and all pixels of the island as 'targets'. It is clear that if a set of grid cells that are considered SwNVI has visual connectivity to a pixel, this means that the pixel has visibility, too.

(3) This procedure is repeated for all the structures considered to be SwNVI so an overall viewshed map for each category (e.g., the total island area that has visual connection with the mobile antennas) is attained. Finally, we end up with seven overall viewshed maps (Figure 4) that depict the area's exposure to visual contact with the SwNVI. When the seven viewshed maps are crossed, a global viewshed map results, depicting categories of spatial typologies according to the degree of the area's exposure to visual contact with the SwNVI. In other words, we understand each 20*20m pixel on the cell grid through its visual connectivity, which translates into acquiring knowledge of the spatial typologies that concern the degree of its visual exposure to SwNVI.

At this point it was considered appropriate to make an aggregation of the categories of spatial typologies, into four major spatial typologies, according to two criteria. The first criteria is according to the character of the SwNVI with which an area has visual contact. Areas that have visual connectivity with XADA are considered as the infrastructure, have the biggest 'negative' visual impact, and need to be separated from all the others. The other six area typologies do not have a substantial objective difference in visual impact, and, thus, they are all grouped in one category. Secondly, according to the potential accumulative effect of an area's visual contact with numerous SwNVI, it is common sense that the number of SwNVI that are visible from each pixel on the cell grid is important. The more visual connectivity there is with more SwNVI, the greater the visual negative impact would be as a result. Synthesising the two aforementioned criteria, we created four major spatial typologies according to 'negative' visual impact due to visual contact with the SwNVI, which are: (a) a pixel that has no visibility in SwNVI; (b) a pixel that has visibility in only one of the SwNVI (XADA excluded); (c) a pixel that has visibility in two or more of the SwNVI (XADA excluded); and (d) a pixel that has visibility in the waste disposal site (i.e., XADA) and probably in most of the SwNVI.

6. Results of visibility analysis

Figure 4 depicts the areas that are exposed to visual contact with each of the seven SwNVI. The surface of the island area that has visual contact, and the percentage of the total island area they represent (Table 1) are calculated for each of the SwNVI, so that the general importance of each SwNVI as a landscape degradation factor can be quantified.

The most widespread SwNVI are the buildings that are characterised as incompatible with the prevailing traditional architecture in Sifnos due to their form, volume, or material used. The areas that have visual contact with this category cover a surface of 11.4 km^2, which is almost 38% of the total island surface.

The second category are the areas that have visual contact with embankments due to road cuts, which includes 9.16 km^2, approximately 31% of the total island surface. The important representation of this category is explained principally by the steep island relief that creates a widespread and serpentine road network.

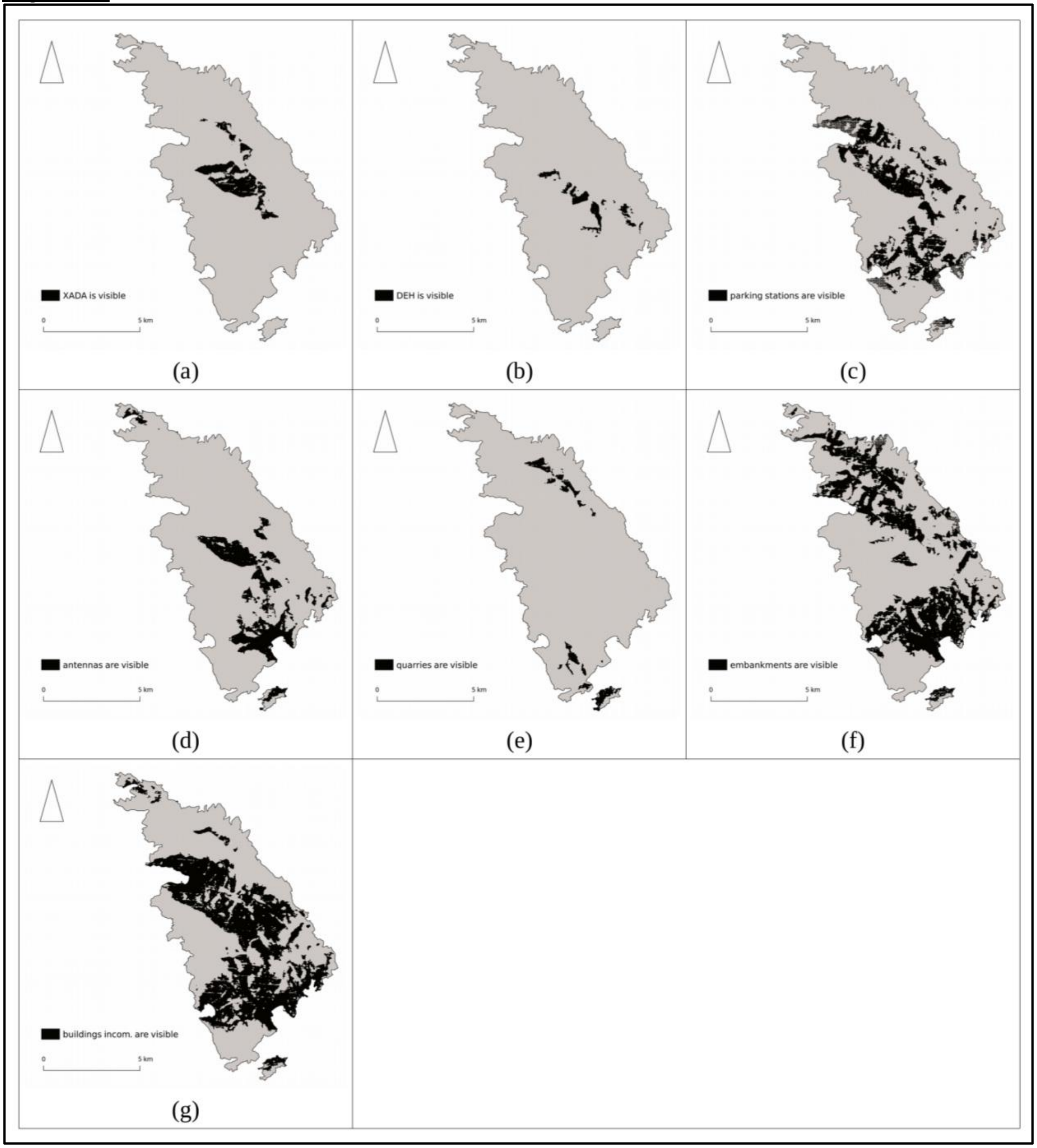
The third category concerns the areas that have visual contact with public parking infrastructures, which concerns 5.6 km^2, which means approximately 19% of the total island surface. It is clear that visibility issues have not been taken into consideration when they were located, and plot availability and ownership status were the principal factors in determining the chosen site.

The fourth category is about the areas that have visual contact with mobile telephone antennas and similar infrastructures, which concerns 3.75 km^2, which means approximately 12% of the total island surface. The panoptic position of this infrastructure is mainly the result of their technical characteristics and their large volume. This obviously serves the infrastructure requirements and the economic efficiency of the investment, but their effect on the landscape should also be taken into consideration more decisively. It is worth noting that many small antennas located at scattered points may be preferable, thus minimising negative impact on landscape.

The fifth category are areas that have visual contact with the uncontrolled waste disposal site (XADA), which involves 1.6 km^2, which means approximately 5% of the total island surface. It is clear that, as a minimum requirement for Sifnos' sustainable development, XADA should be replaced by a landfill site ('Xoros Ygeonomikis Tafis Aporimaton XYTA', in Greek). Another site should be chosen for its location in order to reduce the impact on the environment and minimise negative effects on landscape.

The sixth and the seventh categories are the areas that have visual contact with quarries, and aggregates quarries, and the factory of the public power corporation (DEH). They cover 0.87 km^2 and 0.68 km^2, which means approximately 3% and 2% respectively of the total island area.

<u>Figure 4:</u> The areas that have visual contact with the SwNVI.



Source: © 2017 Tsilmigkas & Derdemezi.

Table 1: The areas that have visual contact with the SwNVI.

Structures with 'negative' visual impact (SwNVI)	Island area that has visual contact with SwNVI	Percentage of total island area that has visual contact with SwNVI
	(km2)	(%)
Buildings incompatible with the prevailing traditional architecture.	11.4	38.19%
Embankments due to road cuts.	9.16	30.73%
Quarries and aggregates quarries.	0.87	2.94%
Mobile telephone antennas.	3.75	12.45%
Public parking spaces.	5.6	18.93%
Factory of the public power corporation (DEH, in Greek).	0.68	2.3%
Uncontrolled waste disposal site XADA.	1.6	5.26%

Figure 5 depicts the major categories of areas with visual exposure to the SwNVI. They concern those areas that have: (a) no visibility to SwNVI; (b) visibility to only one SwNVI (XADA excluded); (c) visibility to two or more of the SwNVI (XADA excluded); and (d) visibility to the waste disposal site (XADA) and probably to other SwNVI.

For each major category of areas with visual exposure to the SwNVI the following are calculated: (a) the surface of the island that they represent and their percentage of the total island area; and (b) the surface and the percentage of the built-up island area that they respectively concern (Table 2). The built-up areas of Sifnos are 0.22 km^2, which means 0.75% of the total island area.

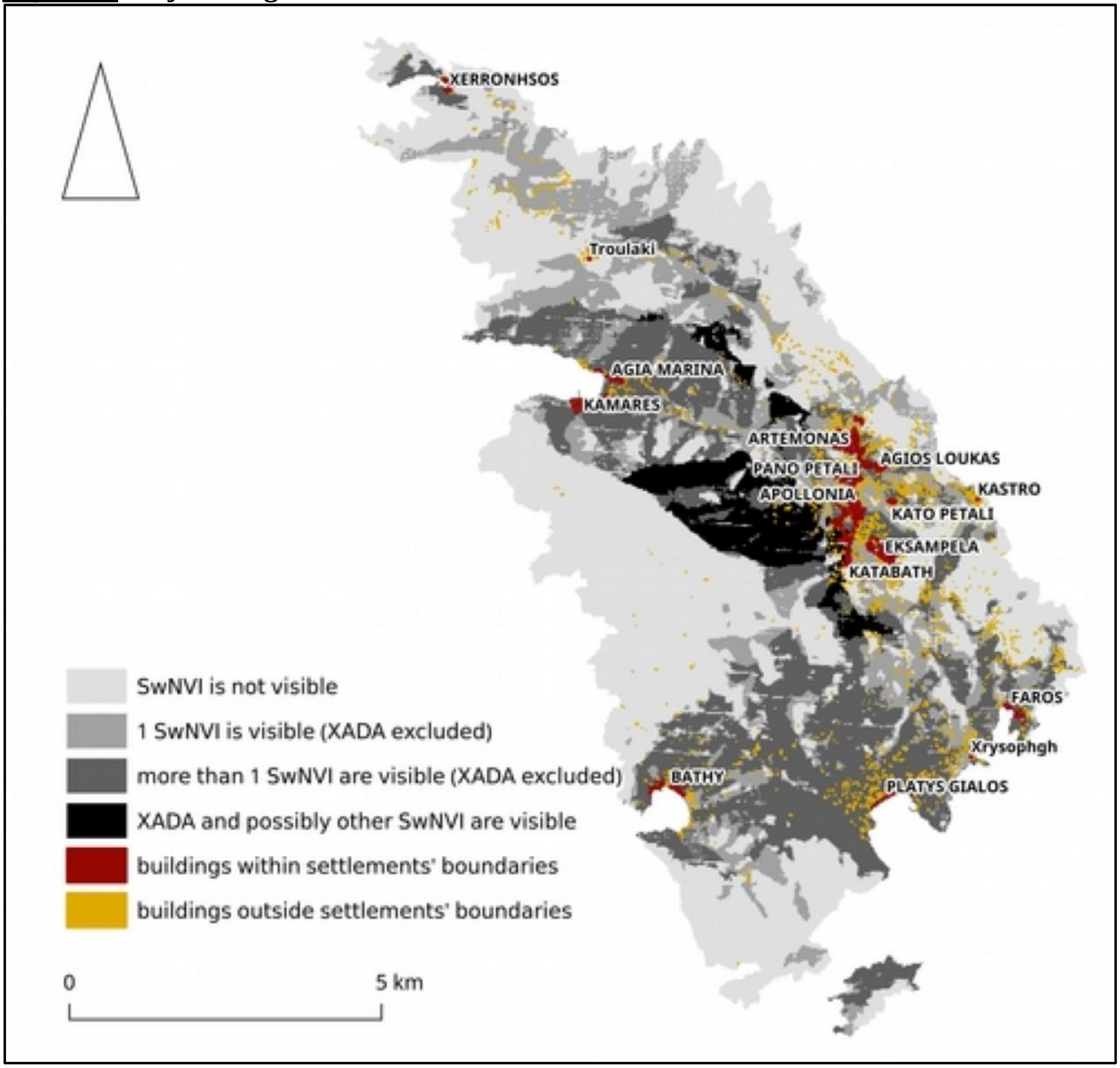
The most widespread category of Sifnos areas with no visual exposure to SwNVI covers 13.8 km^2, which means almost 46% of the total island surface and 0.027 km^2 (or 12%) of the built-up island area. The fact that almost half the island is not exposed to SwNVI is indicative that Sifnos has kept its authentic and outstanding beauty and landscape relatively well-protected. Only a small percentage of the built-up area of the island benefits from this, however.

The second major category of areas with visual exposure to the SwNVI are the areas that have visual contact with two or more of the SwNVI (XADA excluded). This concerns 7.94 km^2, meaning approximately 27% of the total island surface, of which the built-up island area respectively covers 0.13 km^2, meaning almost 57%.

The third major category of area with visual exposure to the SwNVI are those that have visual contact with only one SwNVI (XADA excluded). This concerns 6.27 km^2, meaning approximately 21% of the total island surface; the built-up island area concerns 0.065 km^2, meaning almost 29%. It is clear that at 86%, the overwhelming majority of the island's built-up areas have visual contact with one or more SwNVI.

The fourth major category of areas with visual exposure to the SwNVI are the areas that have visual contact with the waste disposal site (XADA) and possibly other SwNVI. This concerns 1.6 km^2, meaning approximately 5.3% of the total island surface; the built-up island area respectively concerns 0.0038 km^2, meaning almost 1.71%. It is important to note here that only a small percentage of the built-up area has visual contact with island XADA.

<u>Figure 5:</u> Major categories of areas with a view of SwNVI.



Source: © 2017 Tsilmigkas & Derdemezi.

<u>Table 2:</u> Major categories of areas with a view of the SwNVI

Major spatial typologies according to visual contact with SwNVI	Island area	Percentage of the total island area	Built-up island area	Percentage of the built-up island area
	(km^2)	**(%)**	**(km^2)**	**(%)**
No visibility of SwNVI	13.8	46.43	0.027	12.12
Visibility of only one SwNVI (XADA excluded)	6.27	21.18	0.065	29.17
Visibility of two or more SwNVI (XADA excluded)	7.94	27.12	0.127	57.00
Visibility of waste disposal site (XADA) and probably additional SwNVI	1.6	5.26	0.0038	1.71

7. Discussion and conclusions

It is widely accepted that the sustainable management of island landscapes, namely the natural and human-made environment, is essential for local island development. This is true for Sifnos as well. In other words, the attractiveness of the insular area is improved when natural and cultural heritage is enhanced (Gkoltsiou et al., 2013), and the unique identity of the place, 'the spirit of the place', is protected (ICOMOS, 2008). Quality landscapes can make an important contribution to economic development (ICOMOS, 2008, 2011; CEMAT, 2000). To that end, all activities with a spatial footprint, such as agriculture, mining, shipyards and dockyards, and infrastructures such as roads, and energy and communication networks, must above all respect the specificities of the place and avoid or minimise degradation of, and irreversible effects on, the local landscape (CEMAT, 2000).

In Greece, for many decades and despite the significant but patchy efforts that were made before the ratification of Law 3827/2010, two principal characteristics dominated and discouraged landscape protection and its sustainable management (Tsilimigkas & Kizos, 2014). The first was the large number of institutional tools affecting landscape and aiming at its protection, through statutory arrangements supporting certain ad hoc landscape qualities. The second is that many sectoral policies—such as policies on tourism, on transportation, and on energy—are institutionalised and implemented with a significant impact on landscape development. These policies do not ensure coherence within any spatial framework and do not prioritise landscape.

Over-regulation—burdened with a lack of landscape policy and a 'loose', weak spatial planning framework'—makes the role of the ELC particularly important because the ELC sets basic guidelines for landscape policy development. The incorporation of a specific section of the landscape assessment into the twelve Regional Planning Studies (MEECC, 2010) is a concrete step towards adoption of the ELC in the spatial planning framework. More specifically, it concerns 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). Even though many arguments can be made concerning the insufficiency of the methodological landscape approach and its studies applicability, it is clear that for the first time an integrated landscape policy is being institutionalised and incorporated into spatial planning studies at a regional level in Greece (MEECC, 2014).

Multidimensional and complex landscape functions are acknowledged in the present study, but they are not the main concern of the paper, since it focuses on the visual impact of certain constructions with effects on the (a) aesthetic dimension that disrupts the continuity of the typical Sifnos landscape; (b) emotional dimension that distorts 'traditional' landscapes, familiar to the local community; and (c) symbolic dimension that disrupts traditional landmarks, orientation points, and so on. Although Sifnos is considered to have kept its 'authentic' landscape significantly well-protected, the above analysis has shown a significant visual impact of the SwNVI in the island's outstanding-quality landscape. The present study shows that the main degradation factors seem to be caused by (a) those buildings that are not harmonised with the traditional standards in their scale, their form, and the material used; (b) mobile telephone antennas and similar infrastructure, due to their size and the fact that they are located in positions where they can be seen from everywhere; and (c) the visibility of the XADA uncontrolled waste disposal site from built-up areas. As a minimum requirement for sustainable development, it would be appropriate for XADA to be replaced by XYTA (a landfill site). Another site may need to be chosen for its location so that the negative impact on the environment and landscape qualities can be reduced. Here, we should emphasise that the location of any 'structure' should fulfil at least two principal requirements. On the one hand, the site should fulfil the requirements for the effective operation of the infrastructure and its economic efficiency. On the other hand, it should minimise the visual impact of the structures on the landscape.

To conclude, within this context, we consider that visibility computation can be used as a tool to foster island landscape planning. Visibility computation is an efficient way to quantify, at least initially, the visual impact that unplanned and very often unregulated land use in exurban areas of islands, generally connected with residential cluster creation, which are here seen as a principal environmental pressure (Antrop, 2004). There are many questions regarding top-down approaches to landscape planning, but in the present study visibility computation is considered a necessary prerequisite for landscape planning, insufficient as it may be.

References

An, L., Brown, D.G., Nassauer, J.I., & Low, B. (2011). Variations in development of exurban residential landscapes: Timing, location, and driving forces. *Journal of Land Use Science 6*(1), 13-32. https://doi.org/10.1080/1747423X.2010.500686

Antrop, M. (2004). Landscape change and the urbanization process in Europe. *Landscape and Urban Planning 67*(1-4), 9-26. https://doi.org/10.1016/S0169-2046(03)00026-4

Antrop, M. (2006). From holistic landscape synthesis to transdisciplinary landscape management. In B. Tress, G. Tress, G. Fry, & P. Opdam (Eds.) *From Landscape Research to Landscape Planning: Aspects of Integration, Education and Application*. Wageningen UR Frontis Series 12. Dordrecht: Springer, 27-50. https://doi.org/10.1007/978-1-4020-5363-4_3

Baldacchino G. (2006) Islands, island studies, island studies journal. *Island Studies Journal 1*(1), 3-18.

Baldacchino, G. (2004) The coming of age of island studies. *Tijdschrift voor Economische en Sociale Geografie*, *95*(3), 272-283. https://doi.org/10.1111/j.1467-9663.2004.00307.x

Bürgi, M.m Hersperger, A.M., & Schneeberger, N. (2005). Driving forces of landscape change - current and new directions. *Landscape Ecology 19*(8), 857-868. https://doi.org/10.1007/s10980-005-0245-3

CEMAT (European Conference of Ministers responsible for Regional Planning) (2000). Guiding Principles for Sustainable Spatial Development of the European Continent. Hanover: CEMAT,.

CEMAT (European Conference of Ministers responsible for Regional Planning) (2007). Spatial Development Glossary. Strasbourg: Council of Europe Publishing.

Chapman H. (2006). *Landscape archaeology and GIS*. Gloucestershire: Tempus Publishing.

Council of Europe (2000). European Landscape Convention, Florence, 20.X.2000. ETS 176, Strasbourg: Council of Europe.

Davidson, D.A.m Watson, A.I., & Selman, P.H. (1993). An evaluation of GIS as an aid to the planning of proposed developments in rural areas. *Geographic information handling - research and applications*, 251-259.

Detsis, V., Ntasiopoulou, G., Chalkias, C., & Efthimiou, G. (2010). Recent insular Mediterranean land-scape evolution: a case study on Syros, Greece. *Landscape Research 35*(3), 361-381. https://doi.org/10.1080/01426391003746549

Domingo-Santos, J.M., de Villarán, R.F., Rapp-Arrarás, I., & Corral-Pazos de Provens, E. (2011). The visual exposure in forest and rural landscapes: an algorithm and a GIS tool. *Landscape and Urban Planning*, *101*(1), 52-58. https://doi.org/10.1016/j.landurbplan.2010.11.018

EEA (European Environment Agency) (2014). Fast Track Service Precursor on Land Monitoring - Degree of soil sealing 2009. Available at http://www.eea.europa.eu/data-and-maps.

EEA (European Environment Agency) (2000). Digital Elevation Model over Europe (EU-DEM) GMES RDA project. Available at http://www.eea.europa.eu/data-and-maps/data/eu-dem#tab-additional-information.

ELSTAT (Hellenic Statistical Authority) (2011). Population Census. Athens: ELSTAT.

ELSTAT (Hellenic Statistical Authority) (2001). Population Census. Athens: ELSTA.

Ervin, S., & Steinitz, C. (2003). Landscape visibility computation: necessary, but not sufficient. *Environment and Planning B*, 30, 757-766. https://doi.org/10.1068/b2968

Gkoltsiou, A., Terkenli, T.S., & Koukoulas, S. (2013). Landscape indicators for the evaluation of tourist landscape structure. *International Journal of Sustainable Development and World Ecology*, *20*(5), 461-475. https://doi.org/10.1080/13504509.2013.827594

GOG (Greek Official Gazette) (2010). Kyrosi tis Eyropaikis symvasis tou topiou. Efimeris tis Kyverniseos 30/A'/25.02.2010, Nomos 3827/2010. ("Ratification of the European Landscape Convention'. Law No. 3827/2010 (GOG 30/A'/25.02.2010)).

Howard, P.J. (2011). *An Introduction to Landscape*. Farnham: Ashgate.

Howes, D.A., & Gatrell, A.C. (1993). Visibility Analysis in GIS: Issues in the Environmental Impact Assessment of Windfarm Developments. In *Proceedings of EGIS '93*, Fourth European Conference and Exhibition on Geographical Information Systems, Genoa, Italy, 861-870.

ICOMOS (International Council on Monuments and Sites) (2008). Declaration on the preservation of the spirit of the place. Quebec: ICOMOS.

ICOMOS (International Council on Monuments and Sites) (2011). Declaration of heritage as a driver of development. Paris: ICOMOS.

ICOMOS (International Council on Monuments and Sites) (2014). Heritage and landscape as human values. Florence: ICOMOS.

Jakob, M. (2008). *Le paysage*. Paris: Édition Infolio.

Karampela, S. Kizos, T., & Spilanis, I. (2016). Evaluating the impact of agritourism on local development in small islands. *Island Studies Journal*, *11*(1), 161-176.

Karampela, S., Kizos, T., & Spilanis, I. (2014). Accessibility of islands: Towards a new geography based on transportation modes and choices. *Island Studies Journal, 9*(2), 293-306.

Kizos, T. (2008). Rural environmental management in Greece as a cultural frontier between the 'occident' and the 'orient'. *Arbor, CLXXXIV* (729), 127-142.

Lake, I.R., Bateman, I.J., Day, B.H., & Lovett, A.A. (2000). Improving land compensation procedures via GIS and hedonic pricing. *Environment and Planning C*, 18, 681-696. https://doi.org/10.1068/c9911j

Llobera, M. (2007). Modeling visibility through vegetation. *International Journal of Geographical Information Science 21*(7), 799-810. https://doi.org/10.1080/13658810601169865

Maucha, G., Büttner, G., & Kosztra, B. (2010). European validation of GMES FTS Soil Sealing Enhancement data. Institute of Geodesy, Cartography and Remote Sensing (FÖMI), Universitat Autònoma de Barcelona.

MEECC (Ministry of Environment, Energy and Climate Change) (2014). Aksiologisi,anatheorisis kai eksidikefsi tou perifereiakou plaisiou xorotaksikou sxediasmou kai aeiforou anaptyksis periferias Notiou Aigaiou. Ypourgio Perivalontos, Energias kai Klimatikis Alagis (Specification study - assessment, review and specialization of the institutionalized regional frameworks for spatial planning and sustainable development for South Aegean regions). Athens.

MEECC (Ministry of Environment, Energy and Climate Change) (2010). Prodiagrafes meleton aksiologisis, anatheorisis and eksidikefsis thesmothetimenon periferiakon plaision xorikou sxediasmou kai aiforou anaptiskis. Ypourgio Perivalontos, Energias kai Klimatikis Alagis. (Specification studies - assessment, review and specialization of the institutionalized regional frameworks for spatial planning and sustainable development), Athens.

Mouflis, G.D., Gitas, I.Z., Iliadou, S., & Mitri, G.H. (2008). Assessment of the visual impact of marble quarry expansion (1984-2000) on the landscape of Thasos island, NE Greece.

Landscape and Urban Planning 86, 92-102. https://doi.org/10.1016/j.landurbplan.2007.12.009

Menegaki, M.M., & Kaliampakos, D.C. (2012). Evaluating mining landscape: A step forward. *Ecological Engineering 43*, 26-33. https://doi.org/10.1016/j.ecoleng.2011.02.011

Muthukrishnan, N. (2003). Visual Pollution - More Dangerous than You Think It Is. *CPREEC*, Vol. 9, No. 2.

Nutsford, D., Reitsma, F., Pearson, A.L., & Kingham, S. (2015). Personalising the viewshed: Visibility analysis from the human perspective. *Applied Geography 62*, 1-7. https://doi.org/10.1016/j.apgeog.2015.04.004

NCMA (National Cadastre and Mapping Agency) (2014). Orthophotos for Greece 2010. Athens: NCMA.

O'Sullivan, D., & Turner, A. (2001). Visibility graphs and landscape visibility analysis. *International Journal of Geographical Information Science, 15*(3), 221-237. https://doi.org/10.1080/13658810151072859

Ogburn, D. (2006). Assessing the level of visibility of cultural objects in past landscapes. *Journal of Archaeological Science 33*, 405-413. https://doi.org/10.1016/j.jas.2005.08.005

Sander, H., & Manson, S. (2007). Heights and locations of artificial structures in viewshed calculation: How close is close enough. *Landscape and Urban Planning, 82*(4), 257-270. https://doi.org/10.1016/j.landurbplan.2007.03.002

Spilanis, I., Kizos, T., Koulouri, M., Kondyli, J., Vakoufaris, H., & Gatsis, I. (2008). Monitoring sustainability in insular areas. *Ecological Indicators 9*(1), 179-187. https://doi.org/10.1016/j.ecolind.2008.03.003

Spilanis, I., Kizos, T., & Paraskevi, P. (2012). Accessibility of peripheral regions: Evidence from Aegean Islands (Greece). *Island Studies Journal, 7*(2), 199-214.

Tobler, W. (1988). Resolution, resampling, and all that. In H. Mounsey and R. Tomlinson, (Eds.) *Building data bases for global science*. London: Taylor and Francis, 129-137.

Tress, B., Tress, G., Van Der Valk, A., & Fry, G. (2003). *Interdisciplinary and transdisciplinary landscape studies: Potential and limitations*. Wageningen: Delta Series 2, Alterra Green World Research, Landscape Centre.

Tsartas, P., Cocccossis, H., & Vasileiou, M. (2013). Regional Perspectives on Tourism Geographies: The Case of Greece. In J. Wilson, S. A. Clave (Eds.) *Geographies of Tourism - Tourism Social Science Series*. Emerald Group Publishing Limited, 91-103. https://doi.org/10.1108/s1571-5043(2013)0000019006

Tsilimigkas, G., & Kizos, T. (2014). Space, pressures and the management of the Greek landscape. *Geografiska Annaler*: *Series B, Human Geography, 96*, 159-175. https://doi.org/10.1111/geob.12043

Tsilimigkas, G., Stathakis, D., & Pafi, M. (2015). Evaluating the land use patterns of medium-sized Hellenic cities. *Urban Research and Practice, 9*(2), 181-203. Urry, J. (1996). Tourism, culture and social inequality. In Y. Apostolopoulos, S. Leivadi, A. Yiannakis (Eds.) *The Sociology of Tourism: Theoretical and Empirical Investigations*. New York: Routledge, 115-33. https://doi.org/10.1080/17535069.2015.1125940

Urry, J., & Larsen, J. (2011) *The Tourist Gaze 3.0*. Thousand Oaks, CA: Sage.

Vlantou, A. (2010). To topio os antikeimeno nomikis prostasias: Sxeseis kai antifaseis metaksi kanonon dikaiou kai pragmatikothtas. (The landscape as subject of legal protection: Relations and contradictions between legal provisions and reality). Nomos kai Fysi (http://www.nomosphysis.org.gr).

Vlantou, A. (2012). To topio os perivallontiko agatho: Asimvatotita metaksy dikaiou prostasias kai pragmatikotitas'. (The landscape as an environmental asset: Incompatibility between protection and legal reality.) Nomos kai Fysi (http://www.nomosphysis.org.gr).

Wheatley, D., & Gillings, M. (2000). Vision, perception and GIS: developing enriched approaches to the study of archaeological visibility. In G. Lock (Ed.) *Beyond the map: Archaeology and spatial technologies*. Amsterdam: IOS Press.