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A GIS-based fuzzy analysis for mapping the touristic potential in Lazio Region (Italy)

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Abstract

Sustainable tourism is a key function for socio-economic development in Italy. Identifying cultural heritage, environmental, landscape resources, processes and features is one of the most important strategies for sustainable and efficient urban planning and management. The Italian jurisdictional framework defines regional plans by means of specific laws that govern zoning procedures and regulations with operational guidelines and constraining conditions for urban planning. While urban and land development is the subject of several regionally mapped governing and zoning plans, tourism is often locally regulated, and a national tourism plan is still in a phase of initial implementation. As a result, spatially distributed regulatory and management information regarding the economic, social and cultural value of tourism at the country scale are not available. This research proposes and tests an experimental GIS methodology for mapping the touristic potential using open geo data developed by means of using a quantitative index. The spatial distribution of the tourism potential index presented is based on two main input parameters: landscape diversity and drive-time accessibility from a central mobility location. The first parameter defines the local attractiveness, the second the potential fruition of touristic resources. The Lazio Region, in central Italy, is selected as case study for its rich and heterogeneous landscape heritage, in most cases spread around its internal – not easily accessible – areas. Available geographic data are gathered and processed by means of spatial analysis techniques, in order to obtain numerical values, subsequently classified by GIS-based fuzzy logic measures. Results show a homogeneous map of index-based local destinations' attractiveness, based on easy understandable value-scale, that shall be used as a support decision and policy making tool.

1. Introduction

Italy has one the richest tourism economies in the world because of the abundance of places that owing to their endogenous characteristics, endowment of cultural resources, represent peculiar and varied attractions for tourists (Benassi and Spadoni, 2003). Cultural and environmental heritage, landscape, historic cities and the diversity of Italy's geography represent a unique factor of competitiveness and

international tourist attractiveness, especially in the cultural declination of the sector (Prezioso, 2007; Gemmiti, 2012; Mangano, 2018). The attractiveness of cultural tourism in Italy depends on its peculiar landscape features, which integrate environmental and morphological aspects with historical and settlement values. These factors support the continuous diversification and innovation of the tourism offer from the national and to the local level (Reggiani, 2010). The value of Italy, linked to cultural tourism, is quantified by the 2014-2015 Country Brand Index (Mangano, 2018). The ENIT[1] Triennial Plan 2016-18 has also identified the fundamental elements in the cultural and environmental heritage empowering the tourism sector in Italy at local level and in marginal areas (ENIT, 2016).

National legal instruments protect the attractive Italian features defining local landscapes and cultural assets to be preserved up to the regional scale of territorial plans. Recognition and identification of areas and elements to be protected represent a necessary preliminary phase of planning strategies supporting critical management of socio-economic activities[2].

Operational programs and tools – like the Strategic Touristic Plan (PST) 2017-2022 and the Internal Areas Strategy – are based on the principle that natural and cultural resources are fundamental assets for touristic and recreational purposes, according to strategies of social and environmental sustainability. These are pivotal elements of the revitalization processes of cities and local territories, laying the foundations for rethinking and innovating local socio-economic structures (Morelli, 2003; Gemmiti, 2012). These principles have been developed by the

European Landscape Convention, stating that the promotion of territory for tourist purposes leans on the vast and variegated cultural and natural heritage and also on landscape and its peculiar structures (European Convention, 2000).

These strategic guidelines provide new functions to cultural heritage and landscape, as essential resources for the financial recovery of local territories (Cicerchia, 2003). Cultural heritage and landscape become non-relocatable attractors, contextualized and distinguishable from the original environmental context (Cicerchia, 2003; Prezioso, 2007). Therefore, they are at the base of the territorial planning and government processes, as design frameworks of future prospects for territory and local economies (Dematteis, 1998; Governa, 1998). Cultural and environment assets can thus be considered, from an economic-business perspective, as a symbiotic substratum that gives added value to local development processes (Catturi et al., 2003). Anyway, other many factors can contribute to local tourist development. Factors that play a supporting role for the enjoyment of landscape and tourist services. Cultural and environmental assets become strategic for the tourism sector when connected with other support factors such as services and accessibility, that represent competitive benefits for the territory (Gemmiti, 1999, 2010; Celant et al., 2003).

Geographical marginality is often a limit to the tourist valorization of many Italian internal areas, despite their varied attractiveness. Marginality therefore represents a key to understanding the regional imbalances of the Italian economic and tourism system (Celant, 1999; Celant et al., 2003). Starting from the 80s, the structural changes of the Italian economy have imposed a reflection on the new models of territorial development at the local level (Celant, 1994). In this new vision cultural tourism plays a strategic role in the local economy (Morelli, 2003). Cultural tourism aims at the peculiarity and variety of attractions as a factor to diversify the tourist offer and direct it to the marginal areas. This trend offers new conceptual paradigms as opposed to mass tourism, often due to environmental and socio-cultural degradation (De Vecchis, 1979; Scarpelli, 2003; Montanari, 2003). Infrastructural marginality,

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[1] ENIT acronym indicates the Italian Agency for Tourism. Originally named as Ente Nazionale Italiano per il Turismo, actually it is known as Agenzia Nazionale Italiana del Turismo. It has maintained its original acronym of ENIT.

[2] It is not possible to go into detail on aspects related to landscape planning. However, it is recommended to consult technical reports in support of Regional Landscape Plans which address the strategic planning of territory and the management of activities within it, compatibly with local environmental and historical-cultural structures.

socio-cultural valorisation and protection of environmental balances are three aspects to be combined for a new paradigm of sustainable tourism development. Moreover, in this direction, the strategic guidelines on tourism and local development in Italy are progressing.

According to the guidelines expressed by PST and Internal Areas Strategy, in the National Plan of Tourist Mobility, adopted by the Italian Ministry of Infrastructure and Transport (MIT), accessibility represents a fundamental factor to reduce the marginalization of internal endogenous areas and local resources (MIT, 2017). This plan proposes an innovative model of sustainable mobility, by the integration of traditional infrastructure networks (such as primary roads, railways, stations, road junctions and airports) with linear infrastructures relating to slow mobility such as historical and rural pathways and cycle paths. This innovative model aims to connect new touristic destinations to the main flows of human mobility.

Nevertheless, those national plans are generally based on qualitative subjective analysis rather than objective data-driven models. While subjective models are generally based on user driven evaluation and perception of territorial elements and processes, for data-driven models we mean analytical models that are based on the collection and analysis of quantitative data associated with physical features and the corresponding dynamics. The wider diffusion of subjective models, with respect to data-driven model, is generally motivated by the extreme difficulty in defining the quantitative criteria and parametrization of cultural and environmental assets.

This research investigates a data-driven framework and processing model for large scale quantitative analysis of touristic asset potential. The procedures are based on several data processing steps and in particular: input data gathering and preprocessing; data homogenization for importing the several diverse data sources into one unique processing environment; data format conversion (vector to raster) for developing the weighted sum of input geospatial layers. This modeling framework is applied to the Lazio Region, a landscape resource with a rich and diverse domain located in Central Italy.

The selection of Lazio as case study is motivated by the peculiar characteristics of the regional landscape that include the majority of landscape features that may be found on the national scale (Pasquinelli D'Allegra, 2007). These peculiar structures are based on geomorphological and historical-settlement variety, the result of stratifications in the course of geological and human history that has formed different landscape features (Caputo, 2007)[3]. On this geomorphological substratum, environmental settlements and urban systems have been developed over time as demonstrated by areas of archaeological interest, the network of historical roads, rural villages as well as the diverse land, ecological and forest uses and functions (Pavesi, 2007). This case study is also suitable for testing the effectiveness of this data processing model for some critical aspects of the domain of interest. Those critical areas are mainly linked to the unbalance of the major urban systems (Rome in particular) and the related detriment of the physical and biological components of the urban landscape: cementification, urbanization and mass tourism have often impacted the environmental and ecological connections, jeopardizing the ecosystem balances and the conservation of widespread cultural heritage (De Vecchis, 1979).

Nonetheless, these resources are often located in marginal areas, relating to infrastructure networks and main hubs of mobility. This work employs open geo data from institutional web platforms of regional administrations, released to support local territorial planning and the government of the territory[4]. The results presented point out critical elements due to heterogeneity of the available open data. Nevertheless, they show the potential of GIS tools to implement quantitative analysis on a large scale to support territorial planning, decision and policy making.

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[3] Caputo identifies five varieties of landscape in the Lazio Region: volcanic, coastal, flat, karstic and glacial.

[4] GIS data and tools increasingly support spatial and regional planning. In this regard, several Italian regional entities have created special platforms for the sharing and public release of digital information in the form of open data.

2. Multi-criteria approach using GIS tools: an overview

Geospatial layers depicting the several pieces of information related to territorial resources and functions can be analyzed by means of GIS mathematical and statistical methods – as weighted sum (WS) and fuzzy analysis (FA) – with the aim of producing a summary dataset inheriting the combination of the input information. The weighted sum summarizes the different criteria useful for decisions in numerical values, according to the incidence they take in the final decision. Fuzzy analysis is a value standardization technique on a continuous scale from 0 to 1. Formally, it is an extension of Boolean logic (where a value is 1 or 0, true or false) to evaluate the suitability level of a property (Zadeh, 1975).

WS and FA, implemented in a GIS environment, are useful tools for developing territorial marketing, business and location intelligence strategies (Carver, 1991; Jiang and Eastman, 2000; Malczewski, 2006; Eldrandaly, 2013). WS and FA are useful methods to find location advantages in the distribution and management of public services (related to health, transport or education for example), productive, commercial and economic activities or to support urban and regional planning (Joerin et al., 2001; Gorsevski et al., 2011; Riad et al., 2011; Nyeko, 2012; Rikalovic et al., 2014; Mele and Poli, 2017).

Cultural activities and tourist promotion may take advantage of geo data and GIS tools that are usually employed to recognize and identify resources, attractions and services, spread around a specific geospatial context (Boyd and Butler, 1996; Boes and Cottrel, 2007). These elements define the structural territorial framework, in which tourist planning activities are implemented. Different studies propose innovative spatial analysis methods, based on a multi-criteria approach, in order to find the best location facilities to support and implement the fruition of cultural and natural heritage for planning and tourist purposes. In this way, different types of data are integrated to find the best potential of cultural and tourist development based on cultural heritage, natural and ecological resources, infrastructure networks and accessibility, public services, morphology,

climate and so on. In most cases it deals with experimental cases that consider all or part of the criteria mentioned before.

Some studies use GIS methods and tools to evaluate and classify natural and landscape resources relating to urban proximity (Bunruamkaew and Murayama, 2012; Rahayuningsih et al., 2015). Ahmadi et al. (2012) implemented a GIS method to recognize and rank suitable areas for ecotourism purposes in Ilam Province (Iran) relating to natural and archeological sites, climate, morphology, infrastructure and facilities proximity. Kumari et al. (2010) adopted a complex methodology to index and integrate different values such as vegetation, resiliency, ecology and biodiversity to find potential suitable areas for ecotourism development in the Sikkim District (India). Mele and Poli (2017) proposed a multi-criteria method with GIS tools to identify landscape and ecological services within the Metropolitan Area of Naples (Italy) to support planning and recreational activities. Carver et al. (2012) made recourse to new and innovative GIS models for mapping spatial patterns and the distribution of wildland in two Scottish national parks for recognition and management aims. GIS data and tools can also support recognition and assessment of cultural ecosystem services (CES) as a group of cultural elements and amenities that give nonmaterial benefits to citizenship (Sarukan and Whyte, 2005; De Groot et al., 2010). Studies related to CES focus on mapping ecological and cultural services to improve quality of life and public policies, especially in urban or peripheral areas, measuring the quantity and quality of available resources (Nahuelhual et al., 2013) and their proximity to the most populated areas (Caspersen and Olafsson, 2010; Koppen et al., 2014; Ala-Hulkko et al., 2016). Further studies identify and classify potential ecotourism sites, based on spatial centrality and network analysis to evaluate connections among villages and little towns (Lee et al., 2012; Yun, 2014).

These cases demonstrate that there are different ways to measure and assess natural, cultural and landscape resources for tourist and socio-economic development or planning purposes. It seems that different methodological approaches are related to specific goals, adopted criteria and to the availability and technical

structuring of data. Recognition, identification and management of local resources for tourist and socio-economic development reflect specific normative and conceptual definitions that can differ on the basis of the geographic context or context-scale. Furthermore, tourist activities can have a strong impact on local social, environmental and economic structures. Therefore, it is noted that those forcing conditions shall be considered in order to develop optimal tailored analyses for tourism development.

Weighted sum and fuzzy analysis are employed to improve multi-criteria analysis, useful to study territorial phenomena with integrated data and homogeneous criteria (Greene et al., 2011; Jeong et al., 2012). Availability and homogeneous data structuring are two essential factors to apply and implement multi-criteria and fuzzy analysis. In this perspective, open geo data play a supporting role for strategic territorial planning and decision making. Divergent methods of data gathering and structuring obstruct comparative and large-scale analysis. Data accuracy and precision are collocated at the basis of efficient analysis. To obtain accurate results, it is necessary to adopt and implement preliminary procedures of data homogenization, in order to set investigation methodologies on objective parameters.

3. Tourism and culture governance in Italian operational guidelines

Strategic planning policies define the operational guidelines governing cultural development and tourist promotion for territories, in particular while promoting emerging touristic destinations (Mangano, 2018). The practical implications of these policies rely on regional planning, socio-economic and environmental frameworks (Magnaghi, 2016).

PST 2017-2022 and Internal Areas Strategy consider tourism as a key-sector on a local scale by stakeholders and local communities' involvement and integration within local development processes that concern internal areas. Internal areas are defined as those areas that are "*meaningfully distant from the centers of essential services offer, rich of important*

environmental and cultural resource, strongly diversified for nature and after secular anthropization processes" (Agenzia per la Coesione Territoriale, 2014). Among the PST's strategic goals are the innovation and diversification of the tourist offer, through the recovery of landscape and identity values and their integration and connection through intermodal infrastructure networks, useful for accessibility and the fruition of local heritage and services. PST's strategic goals are focused on the valorization of natural and cultural heritage, social cohesion and accessibility through innovative and sustainable mobility networks (MiBACT, 2017).

The Italian Cultural Heritage and Landscape Code defines and protects those territory portions with high environmental, historical, cultural and aesthetic values, through specific zoning in which land use is protected by specific regulations in coordination with urban and local level planning (Civitarese Matteucci, 2005; Sciullo, 2008; Marzuoli, 2008). Its main innovations concern the extension of landscape planning to the whole territory, including marginal and degraded areas (Gambino, 2007; Gisotti, 2016) and the definition of territorial transformation rules in which landscape and cultural heritage inherit a design value (Paolinelli, 2011; Poli, 2012; Magnaghi, 2016). For the selected case study, the Regional Territorial and Landscape Plan of Lazio Region (PTPR) establishes territorial frameworks, defined by preliminary recognition and exploratory activities, in order to identify environmental, archeological and historical features of landscape (Regione Lazio, 2007). The PTPR regional planning zones characterize regulated areas associated with constraining definitions that are based on socio-economic frameworks, because they define activities and structural operations that concern territory and land use allowed, also for tourist and recreational purpose (Regione Lazio, 2007).

The PTPR aims to identify and enhance peculiar local frameworks, as a result of consolidated interrelations between nature, cultural dimension, history, land use and local communities.

4. Experimental GIS methodology for mapping the touristic potential

A GIS methodology is here developed to map and index touristic development potential, based on two of the main criteria considered by previously reported strategic policies:

1) Landscape patterns;
2) Accessibility and proximity.

The first criterion refers to zoning and protected areas defined by PTPR Lazio, adopted in 2007. Zoning and protected areas regard every type of resource that characterizes local landscape structures including also buffer areas related to single archeological or architectural sites, historical road networks, buffer areas that delimitate hamlets, towns or villages and protected areas too. The second criterion refers to drive-time areas, calculated on the time route from a common origin point, represented by Roma Termini, the main railway station of the city and one of the main hubs on a regional and national scale. This methodological hypothesis has only an approximate purpose and aims to demonstrate the technical and procedural aspects. It could be applied and implemented by considering other source points (for example: other railway stations, road junctions or specific points of interest). The methodology is divided into the following phases (Figure 1):

a) Data gathering

This analysis employs open geo data, available on the Lazio Region administration's official web portal, referring to landscape zoning and protected areas defined by PTPR 2007. Other data sources are Open Linked Data of the Ministry of Cultural Heritage and Tourism and ISTAT. A verification procedure has also been used with regard to structural and technical data specification (geometry and projection). This procedure is preliminary to the next phase. Only polygonal vector features are chosen for the purpose of this work. Every single data set is projected in UTM WGS84 32 N, to allow the next elaboration and information layer homogenization.

b) Data homogenization into layer

Data homogenization is here performed by an editing procedure applied to attribute table information of geospatial input layers. The goal is to obtain the same information and the same attribute table structure to implement merge functions to aggregate data[5]. This passage does not impact or modify the input layer geometry.

This step is followed by the next step that consists in merging data in order to produce a final homogeneous layer. Layers are descriptive of essential elements that compose landscape and protected areas (Figure 2). This merging procedure produces eight layers, as illustrated in Table 1.
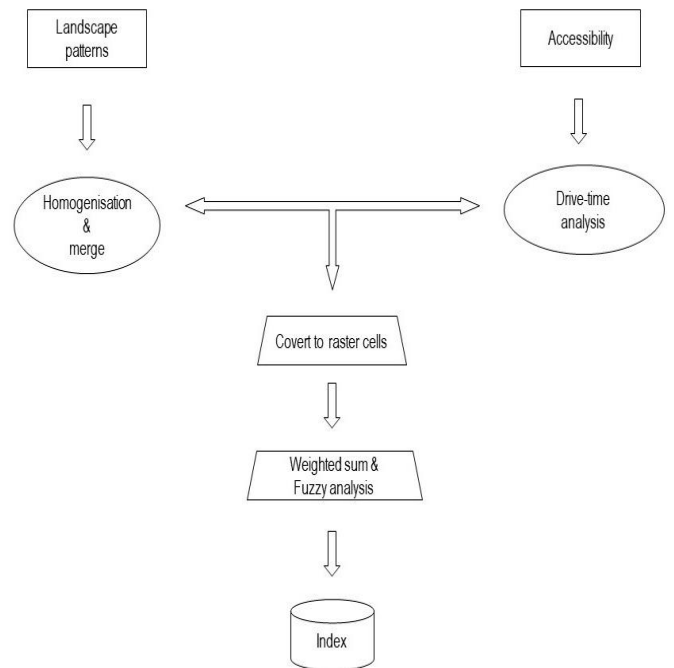

Figure 1. Flow chart of experimental GIS methodology.

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[5] Attribute information refers to these common fields: "*file_name*": refers to the original name of the feature; "*Name*": refers to place name; "*leg_dom*": refers to territorial dominion; "*law*": specific law that determines zoning or protected area; "*content*": refers to the descriptive category of feature; "*leg_cod*": numerical code that identifies the descriptive category.

Code	Layer typology	Description
1	Coastal territories	300 m shoreline
2	Protected areas	Parks and natural reserves, wilderness areas
3	Mountains	Mountain territories over 1200 m
4	Forests & woods	Forest land coverage
5	Archeological areas	Areas, sites and viability of archeological interest
6	Public interest areas	landscape features Human footprints and
7	Hydrology	buffer areas Lake and rivers
8	UNESCO WHL sites	WHL-UNESCO Sites and cultural landscape in

Table 1. List of homogeneous landscape protected area layers.

Drive-time areas were obtained by the ArcGIS Online tool *Perform Analysis, Use Proximity*. The layers illustrated in Figure 3 represent the time-coverage from Roma Termini, divided into four ranges of time:

- 0-30 minutes;
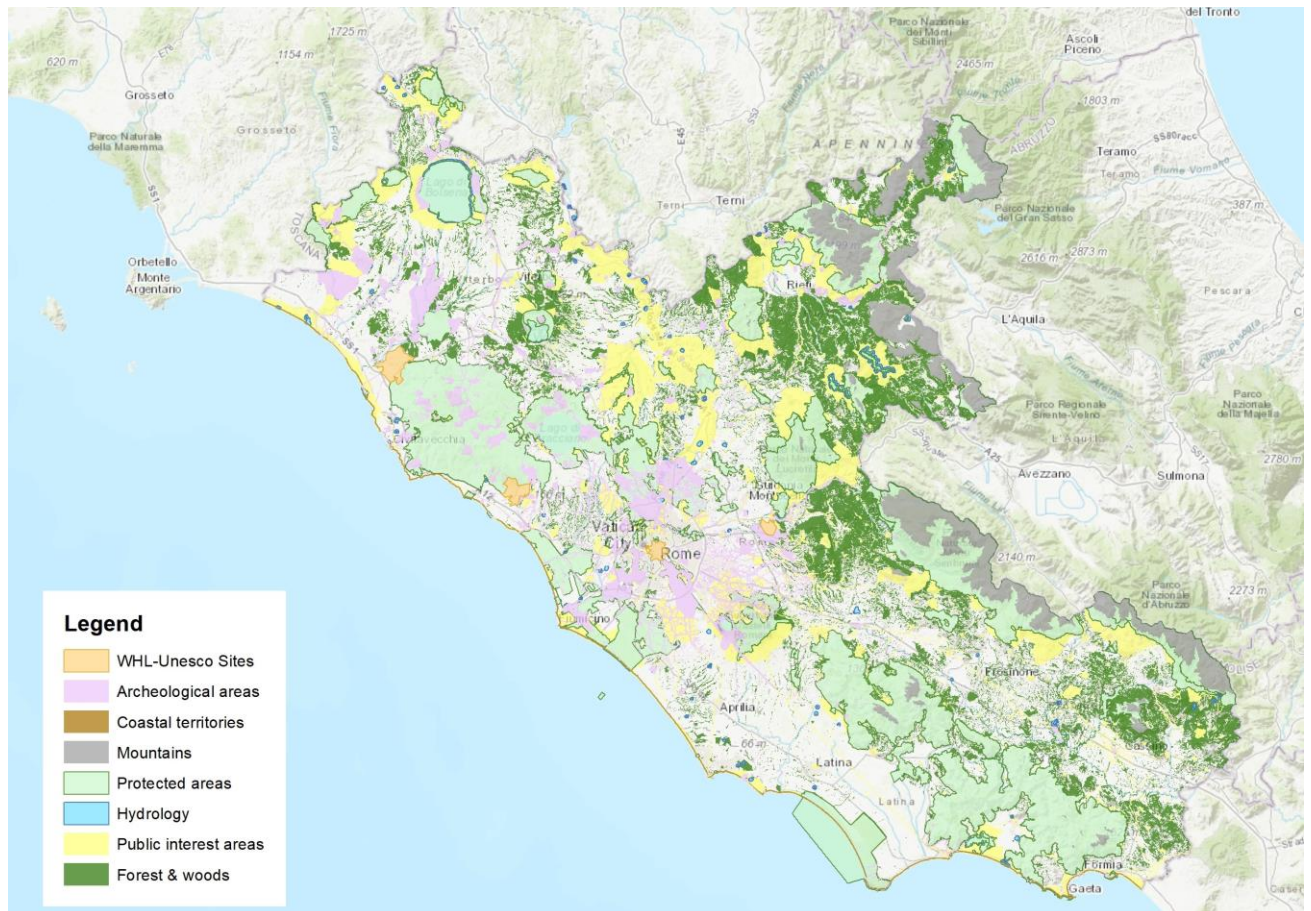- 31-60 minutes;
- 61-90 minutes;
- 91-120 minutes.

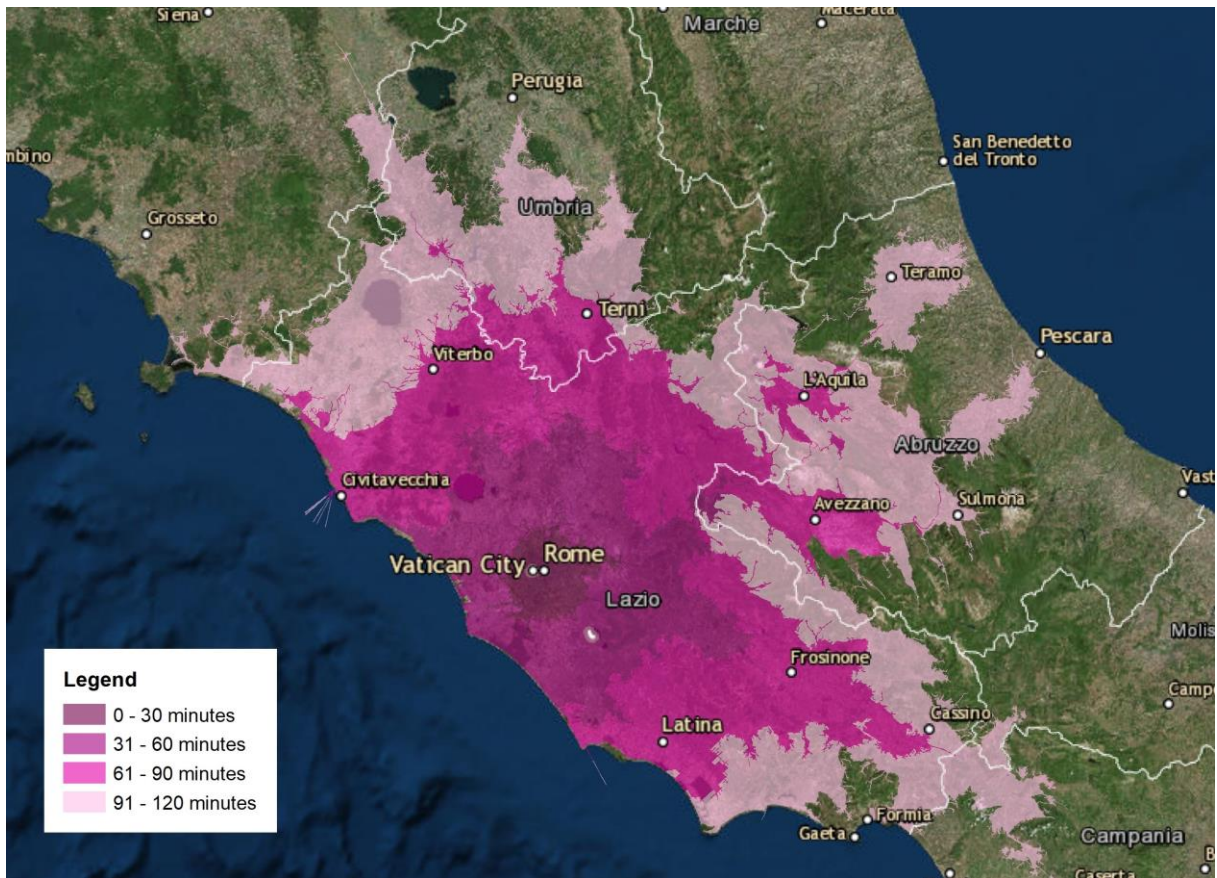Figure 2. Landscape homogeneous layers. Source: elaboration on Open Data Lazio.

Figure 3. Drive-time areas from Roma Termini. Source: elaboration on data ISTAT.

c) Raster value transformation

Vector layers were converted into raster format. This passage has made it possible to implement a sum calculation, to obtain useful values for the final index. The cell raster resolution chosen is 100 meters. This detailed resolution has made it possible to involve every single element in the next elaborations that characterize landscape and heritage value, pointing out aggregation and value hot spots.

d) Weighted sum and fuzzy analysis

The execution of the weighed sum and the fuzzy analysis required a preliminary assignment of weights and values that impact the outcome of the final index estimation. This step integrates the different inputs (cultural and environmental assets on the one hand, accessibility times on the other) into a single output layer representing the distribution of the final values. Since these criteria are difficult to be objectively quantified

on the basis of reference parameters, the assignment of values and weights reflects the compendium of a survey within the working group in order to:

1. Show the methodological effectiveness of multi-criteria analysis in the site suitability selection;

2. Present a flexible and adaptive model of analysis on multiple criteria on different contexts and scale levels.

Homogeneous layers are divided into two general groups:

- Protected landscape areas: combination of layer afferent to natural and cultural heritage that determine zoning and protected areas.

- Accessibility: combination of drive-time areas.

It has assigned a specific weight for each group. It determines the incidence of protected areas (weight = 1) and accessibility (weight =

0.5) in the final elaboration data index. A maximum value of 1 is assigned to attraction elements. Accessibility, in this case, is considered as an element of support to tourist activities.

A specific value for each layer is then applied, to establish the incidence that every landscape and drive-time layer has in the final weighted sum, as shown in Table 2.

Protected landscape areas layers	Value	Weight
Coastal territories	1	1
Protected areas	2	1
Mountains	1	1
Forest & woods	1	1
Archeological areas	2	1
Public interest areas	2	1
Hydrology	1	1
UNESCO WHL sites	3	1
Drive Time areas	**Value**	**Weight**
Drive time 0-30 minutes	1	0.5
Drive time 30-60 minutes	0.75	0.5
Drive time 60-90 minutes	0.50	0.5
Drive time 90-120 minutes	0.25	0.5

Table 2. Values and weights for each layer.

A scale of values from 1 to 3 has been applied to the Protected Landscape areas on the basis of the following criteria: the environmental value was assigned the starting value 1 as components that constitute the physical substratum of the landscape; to cultural heritage an additional value of 2 as areas transformed by the anthropic footprint that over time has defined the evolutionary settlements of the territory; finally to the UNESCO sites the maximum value of 3 for their international relevance as registered in the World Heritage List. The definition of travel times has been set by assigning the maximum value of 1 to areas near the pre-defined point of origin (Roma Termini train station); the other values were assigned by subtracting the fixed decimal value equal to 0.25.

5. Results

Figure 4 illustrates the output layer generated by the proposed analysis that was implemented in the GIS environment.

The weighted sum and fuzzy analyses depict and quantitatively identify areas most suitable for tourist development. The index presented is able to map hotspots associated to high-value of potential attractiveness and aggregation for incoming tourists. Hotspots identify geographic areas where the forcing conditions of touristic value and accessibility are both valuable.

Value and weight assignment were carried out by *Weighted Sum*, within the ESRI ArcGIS *Spatial Analyst* tools. This step returned the row value for every single 100 meter resolution cell. The row values were then elaborated into *Fuzzy Membership* tools, in order to reclassify the value within the numeric range between 0 and 1. This made it possible to have an easy comprehensible interpretation of the cartographic product.

The hotspots reflect the concentration of high values (i.e. tending to the maximum value equal to 1) given by the overlap of the original vectorial information layers. This means that the value of each individual cell (equal to 100 meters) is determined by the number of landscape elements that exist on it, integrated with the accessibility times. The picture that emerges appears to be varied and diversified, with several areas of high value hotspots spread around the region. By comparing the distribution

of the output values (Figure 4) with the distribution and the geographic extension of the landscape elements considered (represented by vector layers - Figure 2), it is possible to see how the higher values are located where the intersection of the elements involves different layers of information.

In a perspective of tourism valorization of the territory, the hotspot areas can lead to a diversification of the offer and encourage innovative forms of the use of environmental and cultural assets.

The results obtained should however be interpreted from an experimental point of view.

A different assignment of values and weights – as well as the adoption of different inputs that integrate the choices made here – can lead to a different cartographic indexation. The subjective assignment of the values and weights performed in the methodology (see paragraph 4d) was carried out for the sole purpose of completing the technical procedure of the work. However, it leaves open the possibility for decision-makers and territorial stakeholders to set their own criteria of analysis based on the needs and objectives established in the planning and decision-making phase.
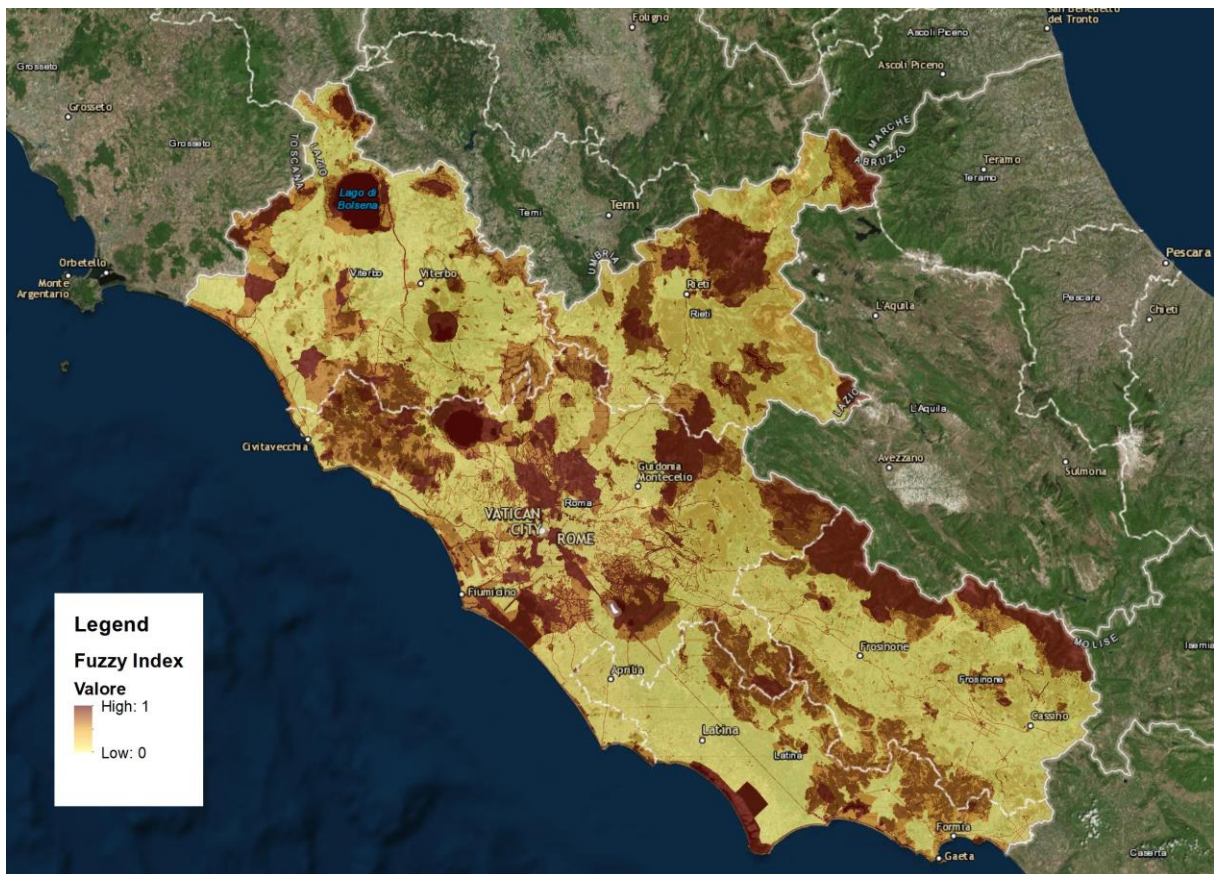
Figure 4. Index map of potential tourist development areas. Source: elaboration on Open Data Lazio and data ISTAT.

6. Conclusions

The final mapping results provide an overview of the Lazio region's touristic potential, pointing out the complexity of the landscape structure. This complexity also represents the potential value of the diversification of the tourist market, that will be tailored to landscape features and territorial frameworks. The test case presented also confirms the efficiency of GIS data and tools to define and implement supporting strategies for decision and policy making, involving territorial and socio-economic frameworks.

The original intent of this research work was to offer a first food for thought in response to the outstanding issues posed by the marginality of the internal areas and the need to innovate the strategy of territorial development around environmental and cultural assets, underlining the potential of digital tools and open geo data available in the context of the continuous and constant digitalization of the economy and public services.

This research presented a new innovative GIS method to find suitable areas for tourist and recreational purpose based on criteria established in the strategic operational guidelines adopted in the Italian national and regional context.

However, we posit that, while achieving the goal of conceptualizing a GIS framework for the objective analysis of touristic territorial performances, our work is far from providing a generalizable and transferable tool. This leads to define several potential further work aspects of this research related to the discussion on the tourist development of the territory in terms of sustainable development and social involvement. Further data types might to be integrated within any future implementation of this GIS methodology in order to:

- Enlarge spatial analysis scale to different geographic areas or regions;
- Consider other essential and strategic criteria related to slow mobility and green infrastructure.

These latter conditions make it possible to find innovative solutions to promote the use of intermodal transport networks, in a sustainable development, raise awareness regarding the use of available resources and enhance a socio-economic and cultural framework perspective.

In this sense, data on land use, agriculture, settlement and economic structures, socio-demographic frameworks, landslide and flood risks can provide complementary information to zoning and landscape features and accessibility time data.

Further innovative contributions can be provided by the use of bottom-up information, in a perspective of the active involvement of citizens and visitors in decision-making processes and planning of the territory, through the use of digital consumer devices (such as smartphones). Information shared, collected, georeferenced and verified by experts can offer new and interesting insights for the geographic knowledge at the basis of the territorial planning and valorization of its resources. Digital tools for the production of geographic data by individual users already exist: consider, for example, Survey 123 for ArcGIS (https://survey123.arcgis.com/), applications for hiking and ecotourism such as Wikiloc (https://it.wikiloc.com/) or iNaturalist (https://www.inaturalist.org/). An increased use of these tools by institutions can be employed to promote processes of social and territorial cohesion with a prospect to a greater sharing of geo-referenced data of collective interest. Nevertheless, open data availability is an essential requirement to make improvements to this GIS methodology. Geographic knowledge and spatial innovative solutions go through the availability and structuration of data information. This is the main challenge posed by digital transformation and digital geography tools.

References

1. Agenzia per la Coesione Territoriale, "Strategia nazionale per le aree interne: definizione, obiettivi, strumenti e governance", 2014, http://www.agenzia coesione.gov.it/it/politiche_e_attivita/piano_ di_Azione_Coesione/index.html.
2. Ahmadi M., Darabkhani M.F. and Ghanavati E., "A GIS-based multi-criteria decision-making approach to identify site attraction for ecotourism development in Ilam Province, Iran", *Tourism Planning and Development*, 12, 2, 2015, pp. 176-189.
3. Ala-Hulkko T., Kotavaara O., Alahuhta J., Helle P. and Hjort J., "Introducing accessibility analysis in mapping cultural ecosystem services", *Ecological indicators*, 66, 2016, pp. 416-427.
4. Benassi C. and Spadoni M., "I siti turistici minori: potenzialità e vincoli. Modelli di analisi", in Colantoni M. (Ed.), *Turismo fattore di sviluppo: Workshop di cosa ha bisogno il turismo: problemi finanziari, di*

occupazione, di integrazione, Bologna, Patron, 2003, pp. 134-150.

5. Boers B. and Cottrell S., "Sustainable tourism infrastructure planning: a GIS-supported approach", *Tourism geographies*, 9, 1, 2007, pp. 1-21.

6. Bunruamkaew K. and Murayama Y., "Land use and natural resources planning for sustainable ecotourism using GIS in Surat Thani, Thailand", *Sustainability*, 4, 2012, pp. 412-429.

7. Carver S.J., "Integrating Multi-criteria evaluation with geographical information systems", *International Journal of Geographical Information Systems*, 5, 3, 1991, pp. 321-339.

8. Carver S.J., Comber A., McMorran R. and Nutter S., "A GIS model for mapping spatial patterns and distribution of wild land in Scotland", *Landscape and urban planning*, 104, 3-4, 2012, pp. 395-409.

9. Caspersen O.H. and Olafsson A.S., "Recreational mapping and planning for enlargement of the green structure in greater Copenhagen", *Urban forestry & Urban greening*, 9, 2010, pp. 101-112.

10. Catturi G., Di Pietra R. and Magliani M., "Patrimonio ambientale e creazione del valore. Il turismo come fattore di cambiamento sociale ed economico-aziendale in provincia di Siena", in Colantoni M. (Ed.), *Turismo fattore di sviluppo: Workshop di cosa ha bisogno il turismo: problemi finanziari, di occupazione, di integrazione*, Bologna, Patron, 2003, pp. 29-57.

11. Celant A., *Geografia degli squilibri: i fattori economici e territoriali nella formazione e nell'andamento dei divari regionali in Italia*, Rome, Kappa, 1994.

12. Celant A., "Turismo e squilibri regionali, riflessioni di metodo e linee di ricerca sulla forza competitiva e sui modelli di organizzazione territoriale del turismo nei sistemi locali italiani", *Rivista Geografica Italiana*, 106, 4, 1999, pp. 445-472.

13. Celant A., Spinelli G., Brogna M., Celata F., Conti Puorger A., Fiorella M., Gemmiti R., Moretti A. and Ruggeri R., "I siti turistici minori e le zone interne del Mezzogiorno d'Italia: ipotesi e prospettive", in Colantoni M. (Ed.), *Turismo fattore di sviluppo:*

Workshop di cosa ha bisogno il turismo: problemi finanziari, di occupazione, di integrazione, Bologna, Patron, 2003, pp. 151-213.

14. Cicerchia A., "Patrimonio culturale e pianificazione del territorio nel dibattito internazionale", in Morelli P. (Ed.), *Beni culturali e turismo nelle città d'arte italiane*, Milan, Franco Angeli, 2003, pp. 112-136.

15. Civitarese Matteucci S., "La pianificazione paesaggistica: il coordinamento con gli altri strumenti di pianificazione", 2005, http://www.aedon.mulino.it/archivio/2005/3/civitarese.htm.

16. De Groot R., Ramakrishnan P., Berg A., Kulenthran T., Muller S., Pitt D. and Wascher D., "Cultural and amenity services", in Hassan R., Scholes R. and N. Ash (Eds.), *Ecosystem and human well-being: current state and trends assessment. Findings of The Condition and Trends Working Group*, Washington, D.C., USA, Island Press, 2005, pp. 455-476.

17. Dematteis G., "La geografia dei beni culturali come sapere progettuale", *Rivista Geografica Italiana*, 105, 1, 1998, pp. 24-35.

18. De Vecchis G., *L'ampliamento di Roma nella costa laziale mediante la seconda casa*, Rome, Pubblicazioni dell'Istituto di Geografia dell'Università di Roma, 1979.

19. Eldrandaly K., "Developing a GIS-based MCE site selection tool in ArcGIS using COM technology", *The International Arab Journal of Information Technology*, 10, 3, 2013, pp. 268-274.

20. ENIT, "Piano Triennale 2016-2018 dell'ENIT-Agenzia Nazionale del Turismo", 2016, http://www.enit.it/images/amministrazionetrasparenteepe/Piano%20triennale%202016_2018.pdf.

21. Gambino R., "Il ruolo della pianificazione territoriale nell'attuazione della Convenzione", in Cartei G.F. (Ed.), *Convenzione Europea del Paesaggio e governo del territorio*, Bologna, Il Mulino, 2007.

22. Gemmiti R., "Il rapporto turismo-sviluppo. Riflessioni per il Mezzogiorno", *Rivista Geografica Italiana*, 106, 4, 1999, pp. 551-571.

23. Gemmiti R., "Urban competitiveness, culture and tourism. Critical aspects in

Rome planning experience", 2012, https://web.uniroma1.it/memotef/gemmiti-roberta-paper-rapporti-ricerca-diffusi-online.

24. Gemmiti R. and Salvati L., "Turismo e competitività territoriale. Un contributo geografico-economico", 2010, https://web.uniroma1.it/memotef/gemmiti-roberta-paper-rapporti-ricerca-diffusi-online.

25. Gisotti M.R., "Dal vincolo al progetto. Il quadro della pianificazione paesaggistica in Italia e una proposta per un modello operativo", in Magnaghi A. (Ed.), *La pianificazione paesaggistica in Italia*, Florence, Firenze University Press, 2017, pp. 1-36.

26. Gorsevski P., Donevska K., Mitrovski C. and Frizado J., "Integrating multi-criteria evaluation techniques with geographic information systems for landfill site selection: a case study using ordered weighted average", *Waste management*, 32, 2012, pp. 287-296.

27. Governa F., "Il Milieu come insieme di beni culturali e ambientali", *Rivista Geografica Italiana*, 105, 1, 1998, pp. 85-93.

28. Greene R., Devillers R., Luther J.E. and Eddy B.G., "GIS-based multiple-criteria decision analysis", *Geography Compass*, 5-6, 2011, pp. 412-432.

29. Jeong J., Garcia-Moruno L. and Hernandez-Blanco J., "A site planning approach for rural buildings into a landscape using a spatial multi-criteria decision analysis methodology", *Land Use Policy*, 32, 2013, pp. 108-118.

30. Jiang H. and Eastman J.R., "Application of fuzzy measures in multi-criteria evaluation in GIS", *International Journal of Geographical Information Science*, 14, 2, 2000, pp. 173-184.

31. Joerin F., Thériault M. and Musy A., "Using GIS and outranking multicriteria analysis for land-use suitability assessment", *International Journal of Geographic Information Science*, 15, 2, 2001, pp. 153-174.

32. Koppen G., Sang A.O. and Tveit M.S., "Managing the potential for outdoor recreation: adequate mapping and measuring of accessibility to urban recreational landscapes", *Urban forestry & Urban greening*, 13, 2014, pp. 71-83.

33. Kumari S., Behera M.D. and Tewari H.R., "Identification of potential ecotourism sites in West District, Sikkim using geospatial tools", *Tropical ecology*, 51, 1, 2010, pp. 75-85.

34. Lee S.H., Choi J.Y., Yoo S.H. and Oh Y.J., "Evaluating spatial centrality for integrated tourism management in rural areas using GIS and network analysis", *Tourism Management*, 34, 2013, pp. 14-24.

35. Magnaghi A. (Ed.), *La pianificazione paesaggistica in Italia*, Florence, Firenze University Press, 2017.

36. Malczewski J., "Ordered Weighted Averaging with fuzzy quantifiers: GIS-based multicriteria evaluation for land use suitability analysis", *International Journal of Applied Earth Observation and Geoinformation*, 8, 2006, pp. 270-277.

37. Mangano S., *I territori culturali in Italia: geografia e valorizzazione turistica*, Rome, Carocci, 2018.

38. Marzuoli C., "Il paesaggio nel nuovo Codice dei Beni Culturali", 2008, http://www.aedon.mulino.it/archivio/2008/3/marzuoli.htm.

39. Mele R. and Poli G., "The effectiveness of geographical data in multi-criteria evaluation of landscape services", *Data*, 2, 9, 2017.

40. Ministero dei Beni e delle Attività Culturali e Turismo (MiBACT), "Piano strategico di sviluppo del turismo 2017-2022", 2017, http://www.turismo.beniculturali.it/home-piano-strategico-del-turismo/.

41. Ministero delle Infrastrutture e dei Trasporti (MIT), "Viaggiare in Italia. Piano straordinario per la mobilità turistica 2017-2022", 2017, http://www.mit.gov.it/comunicazione/news/piano-straordinario-mobilita-turistica/nuovo-piano-straordinario-della-mobilita.

42. Montanari A., "Il turismo nelle città d'arte. Il contributo della geografia economica", in Morelli P. (Ed.), *Beni culturali e turismo nelle città d'arte italiane*, Milan, Franco Angeli, 2003, pp. 41-91.

43. Morelli P., "Beni culturali e città d'arte in Italia", in Morelli P. (Ed.), *Beni culturali e turismo nelle città d'arte italiane*, Milan, Franco Angeli, 2003, pp. 11-24.

44. Nahuelhual L., Carmona A., Lozada P., Jaramillo A. and Aguayo M., "Mapping and

recreation and ecotourism as a cultural ecosystem service: an application at the local level in Southern Chile", *Applied Geography*, 40, 2013, pp. 71-82.

45. Nyeko M., "GIS and Multi-Criteria Decision Analysis for land use resource planning", *Journal of Geographic Information System*, 4, 4, 2012, pp. 341-348.

46. Paolinelli G. (Ed.), *Habitare. Il paesaggio nei piani territoriali*, Milan, Franco Angeli, 2011.

47. Pasquinelli D'Allegra D., "Suggestioni letterarie dei paesaggi laziali", in De Vecchis G. (Ed.), *Per una geografia del Lazio*, Rome, Kappa, 2007, pp. 95-130.

48. Pavesi A., "Gli ambienti del Lazio", in De Vecchis G. (Ed.), *Per una geografia del Lazio*, Rome, Kappa, 2007, pp. 43-68.

49. Poli D. (Ed.), *Regole e progetti per il paesaggio. Verso il nuovo piano paesaggistico della Toscana*, Florence, Firenze University Press.

50. Prezioso M., "Cultural Heritage: tra azione locale partecipata e pratiche innovative per il turismo", in Bencardino F. and Prezioso M. (Eds.), *Geografia del turismo*, Milan, McGraw-Hill, 2007, pp. 219-252.

51. Rahayuningsih T., Harini Muntasib E.K.S. and Prasetyo L.B., "Nature based tourism resources assessment using geographic information system (GIS): case study in Bogor", *Procedia Environmental Sciences*, 33, 2016, pp. 365-375.

52. Reggiani A.M., "Il turismo culturale. Nuovi orientamenti di sviluppo economico-sociale", in Italian Ministry of Cultural Heritage and Activities (MiBAC) (Ed.), *Il turismo culturale, nuovi orientamenti di sviluppo economico-sociale* (Milan, February 18th-21st, 2010), https://www.beniculturali.it/mibac/multimedia/MiBAC/documents/1266332066827_OpuscDef_bassa.pdf.

53. Regione Lazio, "Piano Paesistico Territoriale Regionale-Relazione", 2007, http://www.regione.lazio.it/rl_urbanistica/?vw=contenutiDettaglio&id=71.

54. Riad P.H.S., Billib M., Hassan A.A., Salam M.A. and Nour El Din M., "Application of the overlay weighted model and Boolean logic to determine the best locations for artificial recharge of groundwater", *Journal of Urban and Environmental Engineering*, 5, 2, 2011, pp- 57-66.

55. Rikalovic A., Cosic I. and Lazarevic D., "GIS-based Multi-Criteria Analysis for industrial site selection", *Procedia Engineering*, 69, 2014, pp. 1054-1063.

56. Scarpelli L., *Turismo e pianificazione del territorio: parte quarta. Appunti dalle lezioni di organizzazione e pianificazione del territorio*, Rome, Kappa, 2003.

57. Sciullo G., "Il paesaggio fra la Convenzione e il Codice", 2008, http://www.aedon.mulino.it/archivio/2008/3/sciullo2.htm.

58. Yun H.J., "Spatial relationship of cultural amenities in rural tourism areas", *Tourism planning & development*, 11, 4, 2014, pp. 452-462.

59. Zadeh L.A., "Fuzzy logic and approximate reasoning", *Synthese*, 30, 1975, pp. 407-428.