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Evaluation and mapping of cultural services in terraced landscapes

The case study of the Amalfi Coast

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Abstract Cultural landscapes are a key resource for sustainable development. Among them, terraced landscapes are classified as "evolutive living" landscapes (UNESCO, 2012), an expression of the historical interrelationship between man and his territory. Currently many terraced landscapes are considered at risk because of the changed socio-economic conditions. The need for conservation and effective management of change of this exceptional heritage poses the question of identification of functions and complex values of the landscape, taking into account the needs, views and preferences of local communities. This study aims to identify the terraced landscape values and services based on the ecosystem services theory. It is addressed the issue of evaluation and mapping of cultural services in terraced landscape, with reference to the site of the Amalfi Coast in Campania. The categories of services have been evaluated with the involvement of the local community through a semi-structured questionnaire administered online. The integration of multi-criteria evaluation and spatial analysis in GIS (Geographic Information System) has led to the construction of maps of cultural services, which allow displaying the complex relations that link communities to the landscape. The tools for collaborative mapping (Volunteered Geographic Information – VGI) have been used for the construction of some of the maps of cultural services, integrating the results of the questionnaire with data related to the direct experience of the users.

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INTRODUCTION

Terraced landscapes are considered "the most important system of landscape organization in the Mediterranean" (UNCCD, 2005, p.92) and represent an exceptional landscape heritage to be safeguarded and valued. The need for protection of cultural agro-silvo-pastoral landscapes, and especially of terraced landscapes, is now threatened by the abandonment of traditional practices of maintenance of the territory, closely related to the transformation of the socio-economic context (FAO, 2011; Laureano, 2010).

This research study addresses the topic of the cultural landscape evaluation, with reference to the agricultural landscapes and in particular to the outstanding universal value of terraced landscapes (OUV - Outstanding Universal Value), adopting the approach of the ecosystem and landscape services evaluation.[1]

According to Tudor (2014), landscape evaluation shall distinguish the characteristics (*landscape character*) from its value. Characteristics allow to identify the types of landscape (*landscape typologies*), while the value derives from the functions that each type of landscape is able to perform, that is, the type of needs which it is able to satisfy. Thus, the value of the landscape will have an objective component (connected to the characteristics) and a subjective one (related to the perception) (Tempesta, 2006). The multiple use and non-use[2] values (Randall, 1991; Wilson, 1991; Smith, 1993; Turner *et al.*, 1994; Fusco Girard and Nijkamp, 1997) found in terraced landscapes are generated by functions and services that shall be identified and evaluated to address the most effective strategies for the management of changes, in the perspective of sustainability and preservation of cultural, ecological and socio-economic values of landscape.

The UNESCO recommendations on Historic Urban Landscape (UNESCO, 2011) and the experimental research (Nahuelhual, 2014; Fagerholm *et al.*, 2012) highlight the role of local communities in the identification of the services provided to people by the landscape and the values (benefits) associated with them. In addition, the European Landscape Convention (Council of Europe, 2000) gives local communities a key role in the evaluation of the landscape, which is defined as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". The topics and objectives of this study are strictly related to UNESCO Recommendations and the Convention.

The aim of this work is to develop a methodology for the identification and qualitative and spatial evaluation of services of the terraced cultural landscapes, applied in the UNESCO World Heritage Site of the Amalfi Coast, Italy, in order to: (1) identify their values and key services integrating expert knowledge with perceptions and preferences of the local communities in the implementation of the European Landscape Convention; (2) build a dynamic and flexible Spatial Decision Support System, able of integrating through GIS tools the expert knowledge and the knowledge derived from the experience and perceptions of local communities.

1 The concept of ecosystem services, introduced by Costanza (1997), has been revised and expanded with the Millennium Ecosystem Assessment (MEA, 2003; 2005) which provided definitions, methods and tools for the assessment and mapping on a global scale. Recent scientific research aims at the integration of ecosystem services in landscape planning (de Groot *et al.*, 2010; Hermann et al., 2001; Fagerholm, 2012; Hermann *et al.*, 2013). This area of research has led to the definition of landscape services, identified in the scale of territorial planning.

2 The Total Economic Value (VET) of a good is defined as the set of use values (direct and indirect) and the values of non-use: existence value (the value that individuals attribute to the existence of the good), option value (the value that individuals attribute to the good in view of the future and / or potential use), bequest value (including the value of the property for future generations).

The proposed methodology has revealed, through the tool of the evaluation questionnaire, preferences and knowledge of different categories of stakeholders in the site of the Amalfi Coast, for the construction of a grid of weighted indicators and their subsequent mapping.

THE APPROACH OF ECOSYSTEM AND LANDSCAPE SERVICES IN THE LITERATURE

According to OECD's (2001), in landscape assessment it is necessary to distinguish the characteristics from the value.

The characteristics are defined as the objective components of the landscape. The combination of the characteristics that result from physical and socio-economic variables, along with their interrelationships, define the character of the landscape.

The value of the landscape depends on the **functions** that it is able to perform for people. If people receive services from the landscape, and derive benefits from it (assessed with monetary and non-monetary techniques), it is possible to assess a "landscape value" (Tempesta and Thiene, 2006).

The landscape value to people (residents or visitors) can be evaluated through qualitative (objective or perceived quality) or quantitative approaches (amount of services or benefits enjoyed by people).

The approaches to the evaluation can be summarized as follows (Figure 1):

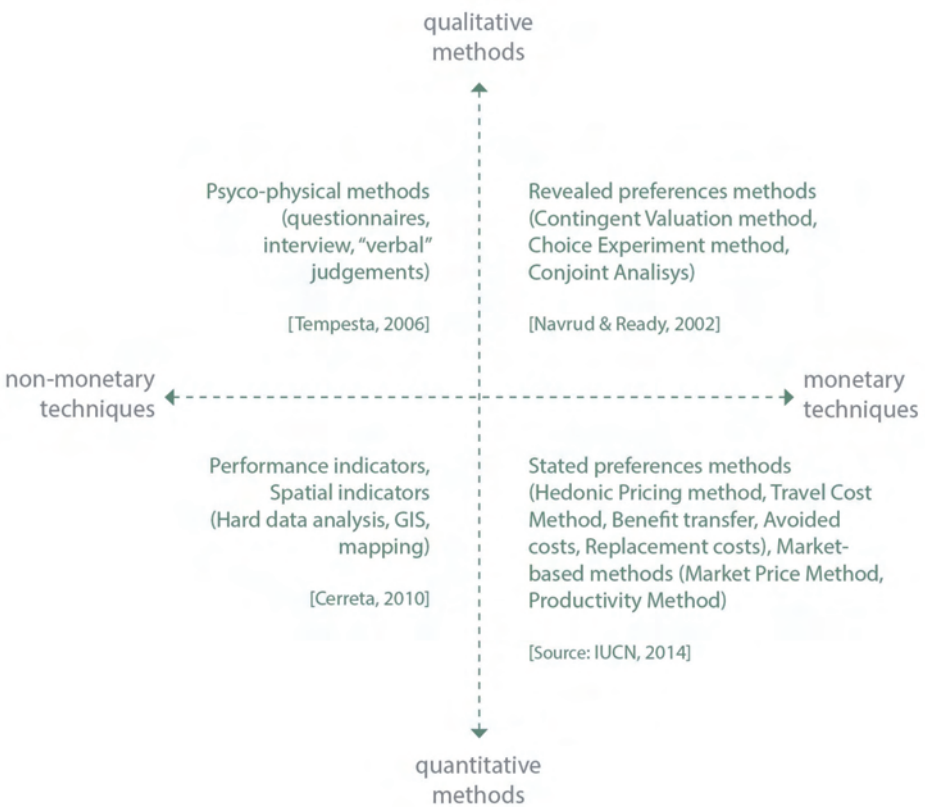

Figure 1 Evaluation approaches to the landscape *Source: author processing*

In last years, several international studies have been realized for the identification, spatial visualization and evaluation of services and benefits at scale of natural ecosystems, in order to improve the decisions on the protection / enhancement of the environment and to monitor the impacts on community wellbeing. Many studies carried out are intended to create a common evaluation framework for the construction of indicators and maps of services to improve the knowledge of the territory. The studies on ecosystems services increased since the 90s (Costanza, 1997; Daily, 1997; De Groot *et al.*, 2002). Services have been classified according to functional categories, organizational categories related to biotic entities, or descriptive categories (Table 1).

Authors	Ecosystem category	Ecosystem services
Lobo (2001); De Groot et al. (2002	Functional	Regulating services, provisioning, habitat, production and information
Norberg (2009)	Organizational	Services associated to particular species, regulating specific exogenous input, or that are related to the organization of biotic entities
Moberg e Folke (1999)	Descriptive	Renewable goods and resources, non-renewable goods and resources, biogeochemical services, information services, social and cultural services

Table 1 Classification of the categories and the related ecosystem services *Source: de Groot et al., 2002*

The classification of functions in the literature has been developed firstly at the scale of **natural ecosystems** and further to the scale of the landscape. The *Millennium Ecosystem Assessment* (MEA, 2005) paved the way for the identification and evaluation of functions, services and benefits of natural and semi-natural ecosystems on a global scale. MEA provides a definition of "ecosystem" and "ecosystem services" in relation to people wellbeing.

The **ecosystem** is defined as a dynamic complex of plants, animals, communities of microorganisms and non-living elements interacting as a functional unit. Man is an integral part of the ecosystem, while ecosystem services are defined as "the benefits that people obtain from ecosystems".

The **landscape** is understood as a multi-functional category, in which it is possible to locate natural aspects but also a range of services, material and immaterial, provided to man through which to trace the conditions for sustainable development (Haines-Young and Potschin, 2010).

The ecological and economic sciences are integrated in the recognition of the concepts of *ecosystem processes*, *ecosystem functions* and *ecosystem services* (Haines-Young and Potschin, 2010; Boyd and Banzhaf, 2007; Lyons *et al.* 2005; Kremen, 2005; de Groot *et al.* 2010).

Processes are complex interactions between biotic and abiotic components, which occur in the normal metabolic cycle of materials and energy in an ecosystem.

Functions are a subset of biophysical structures and ecosystem processes, which can provide services to people.

Services are a set of functions which are of benefit to people directly or indirectly, as concretely useful. Services can be identified both as currently enjoyed and potential.

Benefits are the services used by people in the socio-cultural and ecological context. The benefits correspond to the "values" of an ecosystem / landscape, and determine human wellbeing. The "cascade" scheme of relationships between ecosystems and human wellbeing is summarized in Figure 2.

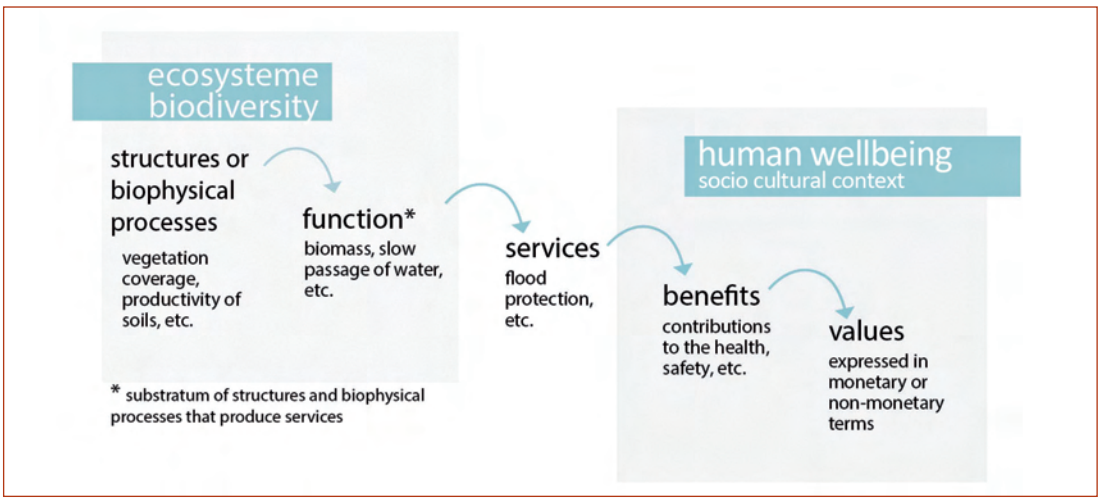

Figure 2 The relationship of ecosystem services for human wellbeing *Source: de Groot, 2010*

After MEA, the TEEB initiative (The Economics of Ecosystems and Biodiversity) (TEEB, 2010) has focused on the economic benefits that derive from natural ecosystems and biodiversity.

From the operational point of view, Maes *et al.* (2013) in the study entitled "Mapping and Assessment of Ecosystems and Their Services" (MAES) propose three main service categories of the landscape in order to standardize landscape research in Europe: provisioning (supply and use of the natural environment for use anthropic), regulating and maintenance (development and maintenance of the natural balances), cultural (tangible and intangible cultural functions).

For the evaluation of the terraced landscape services, the ecosystem approach is a fundamental methodological framework, which needs to be adapted from the global to the local / perceptual scale in order to be properly applied. After analysing the categories of ecosystem services, the categories of services have been analysed at the scale of the landscape, especially the terraced landscape.

The term landscape services was adopted in the field of international research to define the services usable by man resulting from its interaction with the landscape (Limburg, 2002). Unlike the ecosystem services, identified at the larger scale of natural ecosystems, the concept of services at the landscape scale emphasizes the interaction between a physical system, from which natural processes depend, and the variety of use and non-use recognized by man. So, although the biophysical functions can continue to perpetuate itself in the absence of people, the landscape services exist only because there is a community that uses them and gives value to the landscape, in a more anthropocentric perspective.

According to De Groot (2010), communities benefit only a part of the ecosystem services, while the landscape scale reduces the distance between the local actors and the environment, amplifying the usable services. In this perspective, the landscape category can be considered as a human-ecological system that can offer a wide range of benefits, made significant by people as assessed based on ecological, socio-cultural and economic values (De Groot, 2006).

THE CASE STUDY OF THE AMALFI COAST

The analysed approaches and tools for landscape evaluation represent a base of fundamental knowledge for the identification and quantification of the tangible and intangible benefits offered by terraced landscapes, in the perspective of the management of the transformations based on shared goals and needs.

Based on the literature, landscape services are classified into three categories (Maes *et al.*, 2013):

- Provisioning Services
- Regulating and Mainenance Services
- Cultural Services

In particular, the Provisioning Services at landscape scale are defined as materials and energy products historically provided in cultural landscape. Regulating and Maintenance services are defined as services that regulate and maintain the environmental and hydrological balances and biodiversity, providing indirect benefits to people. Cultural Services are defined as the intangible services that derive from the existence of cultural landscape (TEEB, 2010).

This study proposes a methodology for the assessment and mapping of the Cultural Services of the terraced landscapes, applied to the case study of the Amalfi Coast, Italy, UNESCO World Heritage Site of Outstanding Universal Value (OUV). The proposed methodology is based on the identification of key terraced landscape services on the basis of literature studies above described and the involvement of the local community through evaluation questionnaires involving different categories of stakeholders.

The study area has been selected based on criteria such as the representativeness and the presence of the characteristic elements of the type of landscape, the values of uniqueness, authenticity and integrity of the landscape recognized by UNESCO in 1997, the availability of data and institutional information stemming from regional database and literature studies,[3] the ease of access to local associative networks for the detection of knowledge and preferences of the community. In the study area, many associations and NGOs have expressed immediate availability to contribute to the research by providing information relevant for evaluation.

Furthermore, the history and evolution of the coastal landscape have been analyzed in order to identify the area of study. Among others, Pane (1955), Laureano (2001; 2010), Mautone e Ronza (2010), Caneva and Cancellieri (2007), Conforti (1991) Beguinot *et al.* (1994), some studies carried out for the UNESCO Site Management Plan and studies of the association Italia Nostra section of Salerno (2010) were indispensable references for the analysis of the characters and landscape values of the site.

3 Institutional spatial databases used are the mapping of the cover of soils carried out at European level - Corine Land Cover 2006, the Regional Technical Map - CTR, the Utilization of Agricultural Soil Charter of the Campania Region. In addition, the information acquired in a participatory manner through the administration of evaluation questions, were compared with the main studies and publications related to the cultural landscape in the area of the Amalfi Coast.

The identified area includes much of the UNESCO site (Figure 3) and the Lattari Mountains Regional Park. The spatial database obtained represents the cartographic basis for the elaboration of the information gathered through the questionnaire.

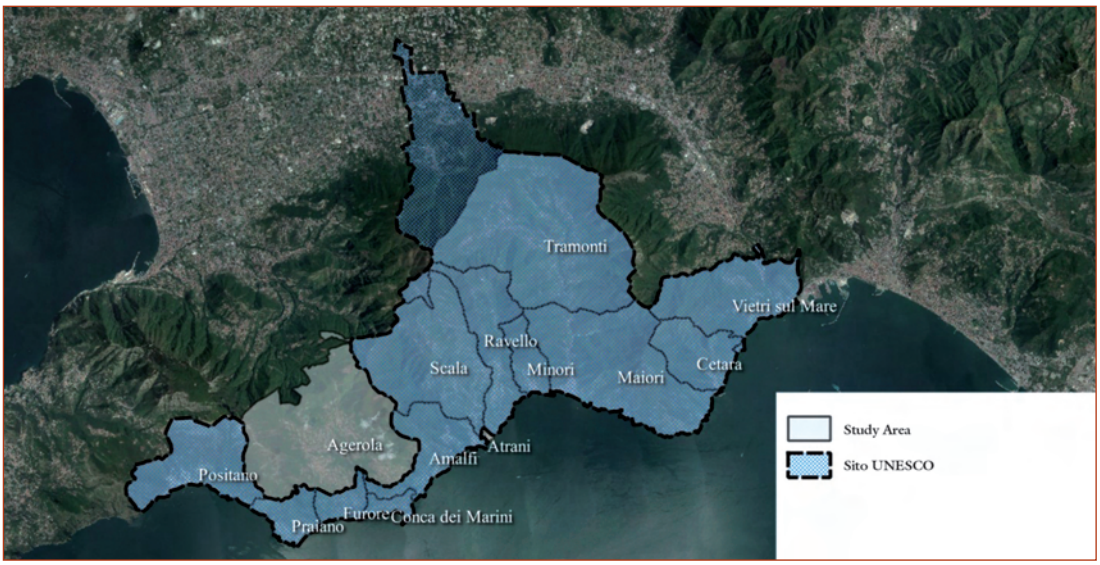

Figure 3 Display area of study and UNESCO site *Source: author processing*

The UNESCO Site Management Plan of the Amalfi Coast produced a detailed analysis of the area, which includes 15 municipalities (Amalfi, Atrani, Cetara, Conca dei Marini, Corbara, Furore, Maiori, Minori, Positano, Praiano, Ravello, Sant'Egidio del Monte Albino, Scala, Tramonti, Vietri sul Mare), a mountainous area covered by forest, 12,536 hectares of pastures and a terraced area of 727 hectares, of which 429 still in use (D'Angiolo, 2011).

There is the need to integrate the knowledge gained in the last ten years of development of the Management Plan to a further examination on the perceptions and preferences of the local community, with respect to the actions of conservation and cultural landscape management, as evidenced by the UNESCO recommendations (2011) the recent international classification and landscape evaluation experiences (Tudor, 2014; IUCN, 2014). The studies produced as part of the Management Plan highlight the need to identify the utility reports and "conveniences" that have historically contributed to the evolution of the cultural landscape: the identification of the economic, social and environmental advantages, and of the services and benefits enjoyed by people, is a critical step to define effective strategies of management, preservation and regeneration of terraced landscapes. The typology of "living evolutive landscape" is characterized by the presence of continuous transformation actions (construction and maintenance of dry stone walls, evolution of settlements, cultivation, land use, use for tourism, etc.), which can be identified as a "use" actions of the landscape, thus as services and benefits. The construction of the terraced landscape services maps and indicators that integrate expert knowledge and subjective perceptions fits into the overall framework of the management of cultural / agricultural landscapes (UNESCO WHS, GIAHS FAO), and constitutes a methodological proposal applicable in other contexts and terraced and at different scales.

METHODOLOGY: TOOLS, DATA, PHASES AND OUTCOMES

The proposed methodology assumes that the judgment of experts and local stakeholders is significant for assessments of landscape (Maes, 2013). Therefore, two evaluation questionnaires have been administered, involving in the first phase a group of selected experts (see Gravagnuolo, 2014), and in a second phase the local community, to define an order of priority with respect to the different services of terraced landscape, and in particular for the construction of "shared" maps of cultural services. The hierarchical structure consisting of "Category - Subcategory - Cultural Service" is highlighted in Table 2.

Category	Subcategory	Cultural Service
Cultural Services (C)	**C1**: Preservation of knowledge, cultural identity	**C1.1** Preservation of traditional knowledge (care of terraces, local construction techniques, cultivation techniques)
		C1.2 Perception of the landscape (places of interest, local identity)
	C2: Spiritual experience	**C2.1** Spiritual enjoyment of the landscape (religious sites, folklore)
	C3: Tourism and recreational services	**C3.1** Recreational and tourist use of the landscape (hotels, parks, beaches, sports, relaxation, wellbeing)
	C4: Scientific and education services	**C4.1** Use of landscape for scientific / educational purposes (scientific research, education in schools, astronomical observatories)
	C5: Aesthetic services and inspiration for art, culture and design	**C5.1** Aesthetic enjoyment of the landscape (beauty, aesthetic pleasure, visual quality of the landscape)
		C5.2 Inspiration for art, culture and design (photos, paintings, stories, landscape representations, design)

Table 2 Cultural Services of terraced landscape *Source: author processing*

Services are identified and assessed according to two parallel and interconnected levels:

- Qualitative assessment (assignment of a priority order);
- Localization, quantification and spatial classification (mapping).

Qualitative assessment (assignment of a priority order)

The allocation of an ordinal scale of preferences with respect to several landscape services has allowed the identification of the weight for the generation of maps that take into account the preferences and knowledge of community.

The weight to be associated with each service is decisive for the assessment of the value and for

the identification of the most effective areas of intervention / actions for the regeneration of the terraced landscape. The knowledge obtainable from "objective" data, or *hard data*, are integrated by the perceptions of the local community through qualitative analysis (Cerreta, 2010), carried out by determining a priority order with respect to the different landscape services. This engagement process allows obtaining a "weight" for each service.
Thus, the process of construction of the "weighted maps" of services allows to: (1) identify complex values that the community give to terraced landscape, implementing the European Landscape Convention and UNESCO's recommendations on Historic Urban Landscape, (2) highlight the priority areas of intervention for regeneration actions.
The integration of the described levels allows to define a matrix of indicators to be used for the evaluation of terraced landscapes services.

Localization, quantification and space qualification (mapping)
Indicators are spatially defined through the mapping process. Spatial analysis is performed in a GIS environment and allows to identify hot spots in the availability of landscape services, increasing the knowledge base in spatial planning. The availability of official data is not homogeneous in different contexts. Therefore, there is the need to identify what are the spatial database available provided by organizations, associations, foundations and other relevant bodies. In the case of the Amalfi Coast, available databases of land cover data have been used (CLC 2006, CTR Campania Region), integrating the basic information with those provided by the users through the questionnaire.
The distribution of cultural services is closely connected with the perceptions of community, which gives value to the landscape. The nature of cultural services, therefore, are identified and mapped through local community engagement processes. The collaborative mapping tools (*Volunteered Geographic Information - VGI*) allows the geolocation of different aspects, conditions and attributes of the landscape (Goodchild 2007a; 2007b; Castelein *et al.*, 2010; Jokar Arsanjani *et al.*, 2013; Jokar Arsanjani and Vaz., 2015). In the case of the Amalfi Coast, some of the information for mapping were derived from online collaborative mapping services (Vaz and Jokar Arsanjani, 2015; Hirata *et al.*, 2015). The questionnaire results were then integrated with geographical information voluntarily provided by users.
Other studies show that it is possible to map cultural services in a participatory process using *focus groups* and questionnaires (Pert *et al.*, 2015; Paudyal *et al.*, 2015; Ramirez-Gomez *et al.*, 2015; Garcia-Nieto *et al.*, 2015; Darvill and Lindo, 2015).

Such opportunities are linked to social innovation and provide a dynamic knowledge of attributes and changes of landscape, otherwise difficult to identify. Several experiences demonstrate the applicability of participatory methods for the evaluation of cultural services (Van Berkel and Verburg, 2012; Plieninger *et al.*, 2013; Nahuelhual *et al.*, 2014; Panek, 2015; Brown and Fagerholm, 2015).

Objectives and structure of the evaluation questionnaire
In order to identify and map cultural services in terraced landscape according to perceptions of stakeholders / users, it was considered necessary to involve the local community in the collection of preferences and information that were not available through context analysis and literature studies. The tool processed is a semi-structured, in-depth interview to be accessed online, built specifically for the site of the Amalfi Coast. The processing of the questionnaire followed the phases of:

1) Definition of objectives;
2) Identification of data needed to be collected for the achievement of objectives;

3) Identification of the categories of stakeholders to be involved;
4) Structuring the questionnaire (introductory section, types of questions, logical jump to the statistical information, final page);
5) Testing of the questionnaire with a small sample of stakeholders;
6) Revision of the questionnaire based on the information gathered during testing (correction of distortion and simplification of the language);
7) Construction of the online questionnaire available through specific services (SurveyMonkey©);
8) Administration of the questionnaire to stakeholders;
9) Data processing and analysis of results.

In implementation of the guidelines of the European Landscape Convention (Council of Europe, 2000), the primary objective of the questionnaire has been defined in the **identification and mapping of cultural services for terraced landscapes** according to the **perceptions** and **preferences** of the **local community**.

The landscape is defined as a complex system which is characterized by multiple functions and services. The ecosystem approach highlights the complex relationships between the ecological, economic and social functions integrating them into an evaluation system with a holistic approach. While in the assessment of ecosystems all functions have value because they contribute to the preservation and transformation of ecosystems, at the landscape scale it is possible to identify the services that contribute significantly to the welfare of the communities, which are therefore more enjoyed and acquire meaning and value in connection with the use (direct, indirect, future). To integrate the knowledge and assessment of the landscape services in decision-making it has been therefore considered necessary to identify the key services and the key values of terraced landscape. This study is focused on **cultural** services, which has operational difficulties and constitutes a gap in the literature of ecosystem and landscape services (Attardi *et al.*, 2014; 2012; Hermann *et al.*, 2001).

A section of the questionnaire has been structured to detect useful information to the assessment of cultural services, through a "socio-cultural" participatory approach, based on data collection with the involvement of community residents and occasional users of the landscape (Hermann *et al.*, 2013; Fagerholm *et al.*, 2012; Nahuelhual *et al.*, 2014). Respondents were asked to indicate places and activities of interest in the study area, in order to build a GIS database for mapping and evaluation of available and potential cultural services. For the purposes of mapping services, the results have been integrated through the detection of the places and hike/panoramic paths reported by users of the collaborative mapping services *Wikiloc*. The geo-data (point, linear, areal feature) have been exported and integrated in the GIS maps.

The questionnaire has been structured in the following sections (see the comprehensive research work for the full version, see. Gravagnuolo, 2015):

- **Introductory section** (explanation of the objectives of the questionnaire, stakeholders involved, expected results and average compilation time);
- **Section 1** (allocation of weights to the categories and subcategories, assessment of indicators)
  – priority order attributed to categories and to terraced landscape services;
  – collection of data linked to places and activities of interest in the study area (cultural services);
- **Section 2** (personal information)
  – socio-economic data of the respondent (age, gender, average individual income, stakeholder category);

- **Concluding section** (questionnaire evaluation, willingness to participate in further research on the landscape).

The questionnaire has been viewed by 229 persons, of which 147 have completed all answers, with a completion rate of about 64%. The Table 3 highlights the extent to which different categories of stakeholders were involved.

STAKEHOLDER	N.	%
Public administrato	8	5,44
Professional or researcher	23	15,65
Operator in tourism	2	1,36
Farmer	3	2,04
Citizen	19	12,93
Member of local associations	7	4,76
Tourist - visitor - hiker	85	57,82
Total "residents"	**58**	**40%**
Total "visitors"	**89**	**60%**
Total "promoters"	**31**	**21%**
Total "operators"	**12**	**8%**
Total "users"	**104**	**71%**

Table 3 Percentage of respondents by category *Source: author processing*

The stakeholders involved have been classified into two main categories: residents and visitors. Among the residents, six categories of stakeholders have been identified, classified into three main groups: promoters, operators and users of terraced landscape (Table 4).

Category	Subcategory	Role in the terraced landscape
Residents	**Promoters**	Public administrator
		Professional or researcher
	Operators	Operator in tourism
		Farmer
		Member of local associations
	Users	Citizen
Non residents	**Visitors**	Tourist or hiker

Table 4 Categories of stakeholders *Source: author processing*

The questionnaire has been administered through the web and with the fundamental support of the local associations. In particular, the ACARBIO Association (Association Amalfi Coast Biosphere Reserve) has collaborated actively in the construction and dissemination of the interview, the results of which has been included to complete the dossier for the application of Amalfi Coast as a Biosphere Reserve (UNESCO MAB Programme). The collaboration of associations has enabled the creation of a network for the initiative, including WWF (World Wide Fund For Nature), Italia Nostra section of Salerno, Hoteliers Association of Amalfi, Youth Forum, Pro Loco, Local Action Groups. The spread of the questionnaire on social networks (Facebook, Twitter, local associations web sites) and to the Solidarity Trade Groups operating within the Amalfi Coast and in the neighbouring area (Salerno, Cava de' Tirreni, Angri) favoured the participation. The questionnaire has been promoted over three weeks in February/March 2015. After the closing of the promotion activities, it was decided to leave the questionnaire open as a dynamic tool for detecting information on the landscape, but also as a communication tool capable of activating reflections and awareness with respect to the landscape values for the community. In fact, by filling in the questionnaire, the user has the opportunity to get definitions and basic information about landscape services, and to communicate his preferences through open fields.

CONSTRUCTION OF "PARTICIPATED" MAPS OF CULTURAL SERVICES

The first part of the questionnaire was dedicated to the processing of an order of priority (or "weight") to the different services of the terraced landscape. The percentage obtained is the number of respondents who selected the specific service as a priority (the choice of selectable services has been limited to 5 out of 15, considering the Provisioning services and t Regulating and Maintenance services - see. Gravagnuolo, 2015).

Here are reported the results related only to cultural services, which have been used in GIS for the construction of maps (Table 5).

Terraces landscape services	%	Weight
Perception of the landscape (places of interest, local identity)	52,40%	0,345
Spiritual enjoyment of the landscape (religious sites, folklore)	13,60%	0,090
Recreational and tourist use of the landscape (hotels, parks, beaches, sports, relaxation, mental and physical wellbeing)	25,90%	0,171
Use of landscape for scientific-educational purposes (scientific research, education in schools, astronomical observatories)	35,40%	0,233
Inspiration for art, culture and design (photos, paintings, stories, landscape representations, design)	24,50%	0,161
Total	**100%**	**1,000**

Table 5 Calculation of the weights attributed to the cultural services of terraced landscape *Source: author processing*

A section of the questionnaire has been dedicated to reporting places of interest in relation to the cultural services indicators (Table 6).

Indicator	Open Question (reporting places)
Perception of the landscape (places of interest, local identity)	It indicates at least THREE landmarks in Amalfi Coast you'd visit a friend.
Spiritual enjoyment of the landscape (religious sites, folklore)	Do you know places of religious and spiritual interest in Amalfi Coast? If so, which ones?
Recreational and tourist use of the landscape (hotels, parks, beaches, sports, relaxation, mental and physical wellbeing)	Do you know trails and hiking paths on the Amalfi Coast? If so, which ones?
Use of landscape for scientific-educational purposes (scientific research, education in schools, astronomical observatories)	Do you know teaching farms in Amalfi Coast? If so, which ones?
Aesthetic enjoyment of the landscape (beauty, aesthetic pleasure, visual quality of the landscape)	Do you know craft and innovative companies on the Amalfi Coast? If so, which ones?
Preservation of traditional knowledge (care of the terraces, local construction techniques, cultivation techniques)	Do you know people who cultivate terraces on the Amalfi Coast? If so, where?

Table 6 Correspondence of indicators of cultural services and questions *Source: author processing*

CONSTRUCTION OF CULTURAL SERVICES MAPS

The maps of cultural services have been developed first using objective information, using spatial data from different sources (institutional database, survey results, data from the VGI service Wikiloc). Subsequently, the "weights" assigned to the services have been added in the maps through spatial analysis in GIS, to get a mapping that would take account of the subjective point of view of the actors involved.

Among the cultural services identified in Table 2, those to whom it has been possible to associate geo-spatial data are the following:

- Perception of the landscape: places of interest, local identity (C1.2)
- Spiritual enjoyment of the landscape (religious sites, folklore) (C2.1)
- Recreational and tourist use of the landscape (hotels, parks, beaches, sports, relaxation, wellbeing) (C3.1)
- Use of landscape for scientific-educational purposes (scientific research, education in schools, astronomical observatories) (C4.1)
- Inspiration for art, culture and design (photos, paintings, stories, landscape representations, design) (C5.2)

Mapping the "Perception of the landscape"

The map of the cultural service "Perception of the landscape" has been built through the reporting of places of interest from stakeholders involved: **494 data** have been reported reports totalling **60 places of interest**.
The map has been realized through the analysis of density with the GIS Tool "Kernel Density" (Spatial Analyst), which shows the intensity of the service in relation to the reporting frequency (Figure 4).

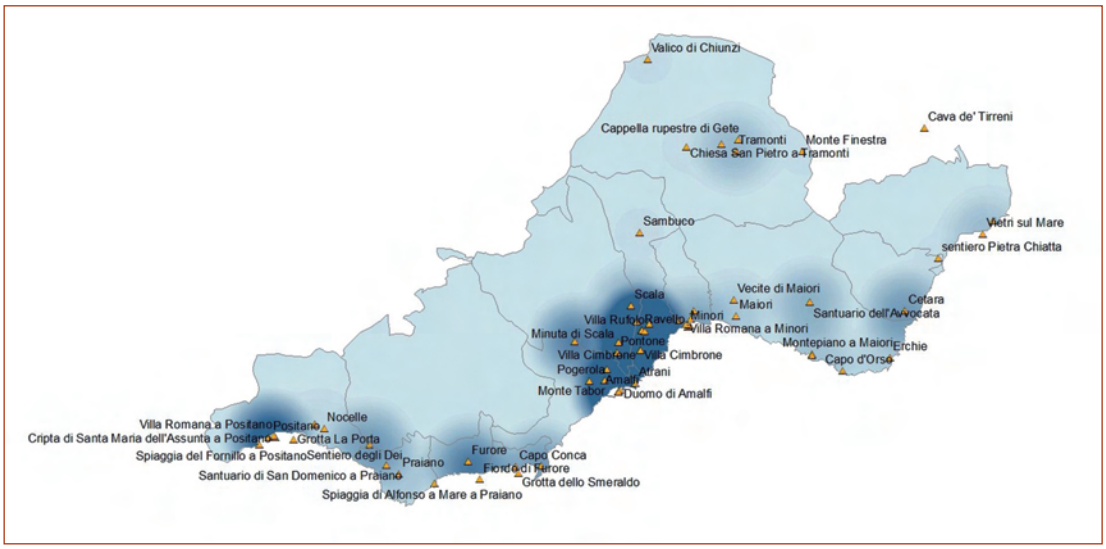

Figure 4 Density of points of interest in relation to the reporting frequency *Source: author processing*

Mapping the "Spiritual enjoyment of the landscape"

The mapping of cultural services related to the spiritual and / or religious landscape experience has been processed using data from 193 reports, resulting in 46 places of interest (Figure 5).

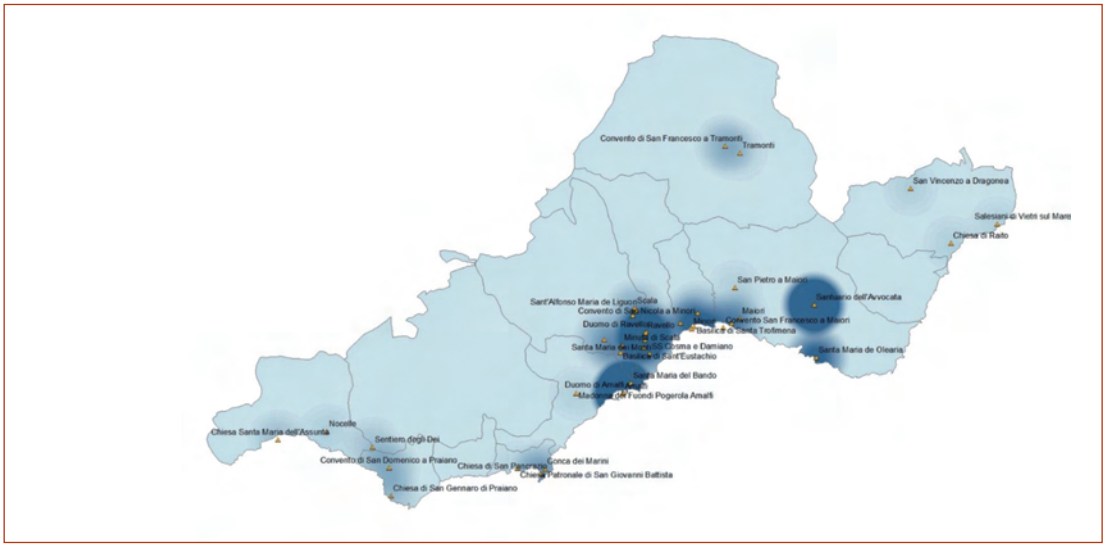

Figure 5 Density map of spiritual services in relation to the frequency of the reports *Source: author processing*

Mapping the "Recreational and tourism use of the landscape"

The recreational and tourism use of the landscape (hotels, parks, beaches, sports, relaxation, wellbeing) is referred to the Subcategory of "tourism and recreation" cultural services. The answer to the question has been set as optional, following a number of reports lower than previous services: a total of 216 respondents provided reports which identify 35 places and hiking paths.

Before processing the data from the questionnaire, the database has been reclaimed by normalizing place names and paths. For the identification of places and paths[4] in the data processing phase, three data sources have been used:

- Bibliographic sources from the literature (Guide to paths in the Amalfi Coast of the CAI association, WWF, other tour guides in print or online format);
- Direct search - geolocation via Google Earth 7.1.2.2041 version of software;
- ICT Services of collaborative mapping (Wikiloc).

The places and the paths were identified on the map in Google Earth and exported to KML. KML database was then imported into ESRI shapefile through the ARCGIS © software.

The term "Volunteered Geographic Information" (VGI) has been introduced by Goodchild (2007b) to describe geographic information generated by users, combining Web 2.0 elements, collective intelligence and neo-geography (Castelein *et al.*, 2010). Among the "collaborative" mapping tools, Wikiloc is a free app developed for the mobile systems aimed at mapping the outdoor paths for different sport activities: trial, trekking, skiing, motocross, offroad, running, climbing, and others.

Routes can be accessed from the website of ***Wikiloc*** (Wikiloc, 2015) or its application on smartphone or GPS device. In addition, Google Earth provides route information made available by the community, on its preconfigured maps. Offering a particularly valuable and rich information service, collaborative mapping provides a flexible and dynamic system for detecting information on the perception and use of the landscape by residents and visitors. It should be noted, in this regard, that the community started in 2006 (Wikiloc, 2015), now having more than two million users, a critical mass sufficient to produce a good effectiveness of social tools and a good reliability of the information offered (Figure 6).

4 The complete list of sites coded for each of the cultural landscape service is available in Gravagnuolo A. (2015), Evaluation of cultural landscapes. Approaches and tools for the protection and enhancement of the terraced systems, Ph.D. Thesis in Methods of Evaluation for Integrated Conservation, Restoration, Management and Maintenance of Architectural Urban and Environmental Heritage, XXVI cycle. Department of Architecture, University of Naples "Federico II", Naples.

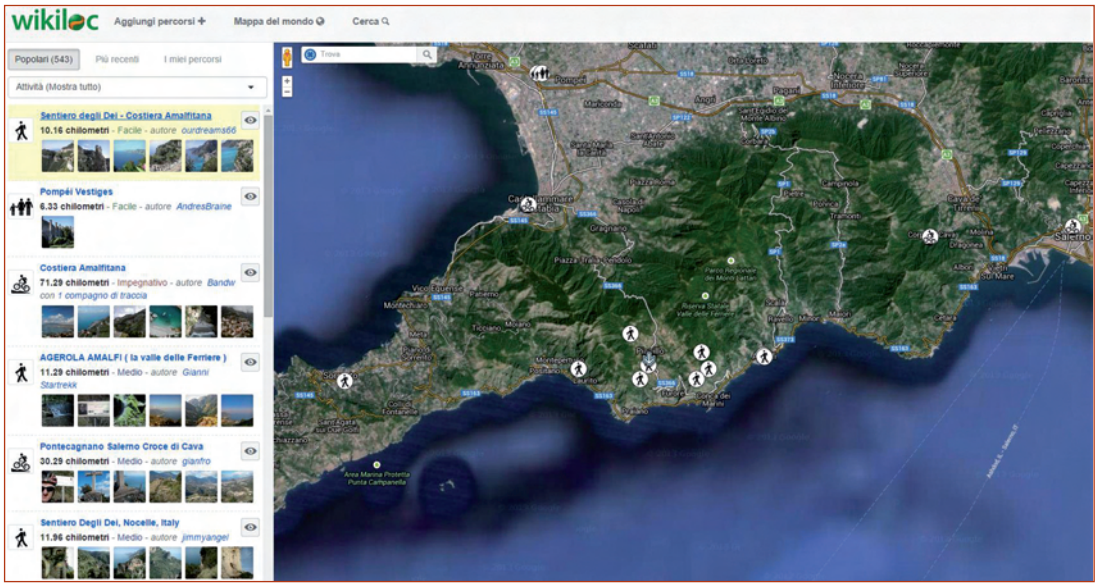

Figure 6 Collaborative mapping of hiking trails in the area of the reference site *Source: Wikiloc.com*

Once carried out the preparations for data processing, the base map has been processed using two distinct types of features: points (places of interest) and lines (paths and theme routes). Two separate maps have been processed and later integrated using the raster format for the spatial identification of the service.

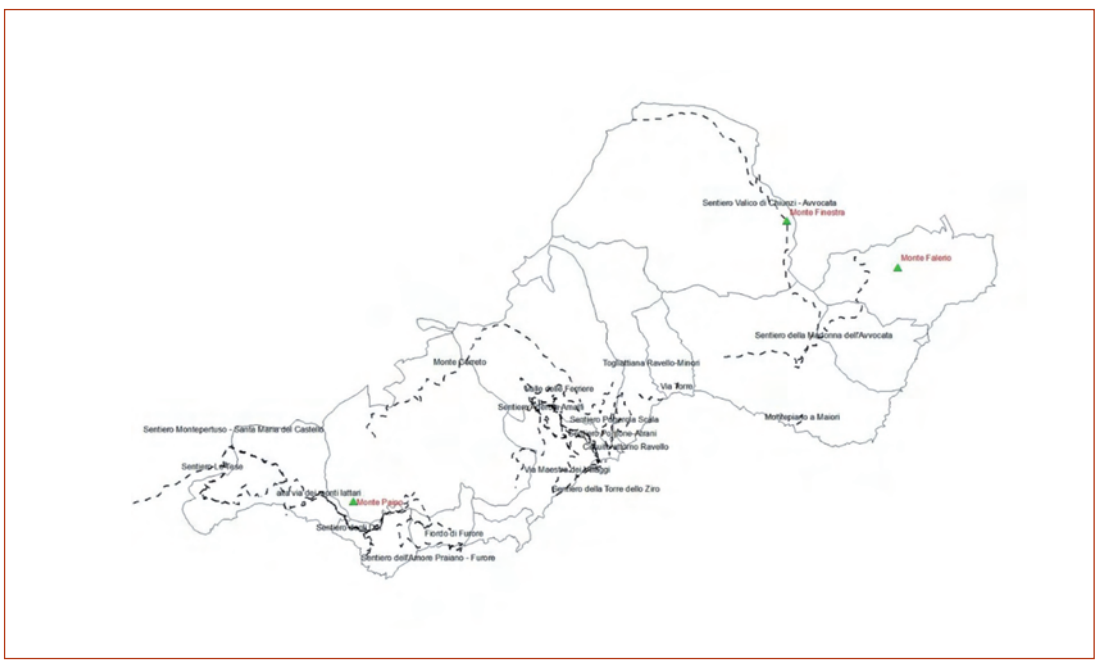

Figure 7 Basic map of the places of interest related to tourism and recreation cultural service *Source: author processing*

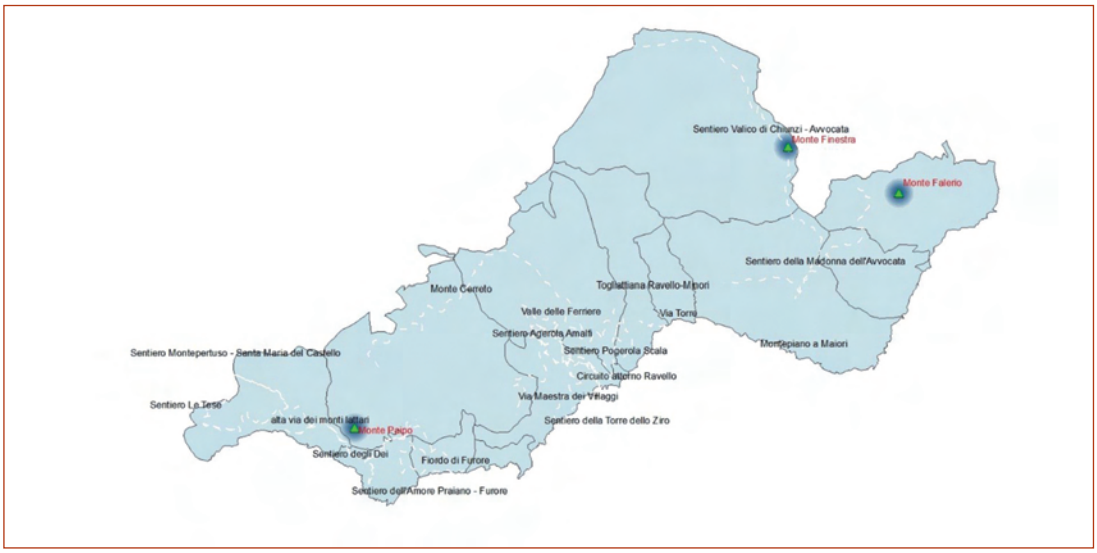

Figure 8 Density map of points of interest in the study area *Source: author processing*

The spatial representation of the recreational use of the landscape through the paths and hiking routes has been created through the GIS Tool "Line Density", using the "frequency" field as an element of "weighing" of the reported location. A map of the density of the paths has been generated, recalculating it with the Tool "Raster Calculator" to normalize the cell values in a [0-1] interval.

The overall map has been processed using raster calculator. The aggregated map of the cultural service "recreational and tourist use of the landscape" is therefore established by aggregation and normalization of values identified through the analysis of spatial density (Figure 9).

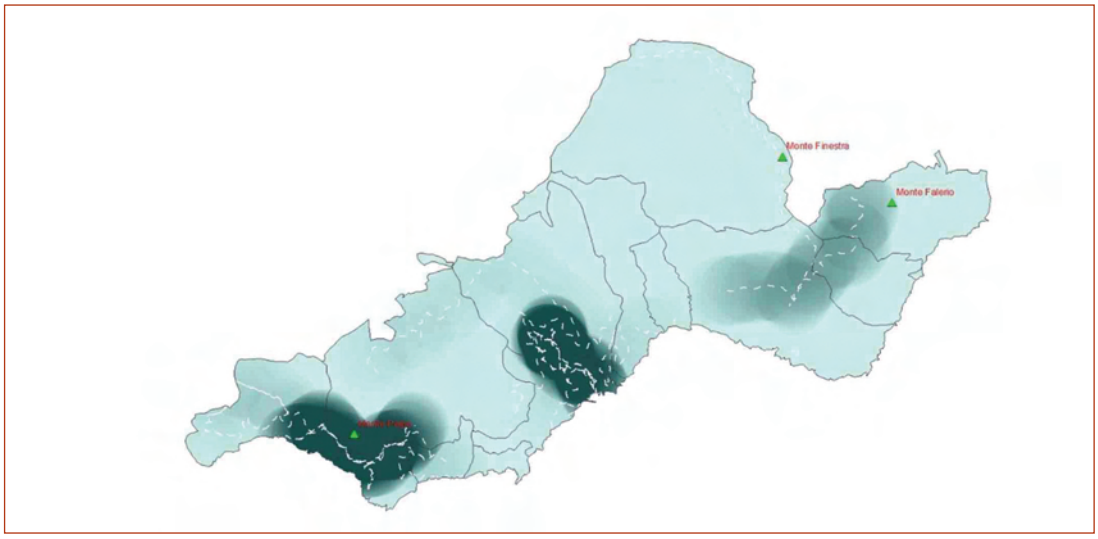

Figure 9 Density map of the recreational use of the landscape (paths), normalized values *Source: author processing*

Mapping the " Use of landscape for scientific-educational purposes"

The mapping of the Use of landscape for scientific-educational purposes has been performed using a total of 9 recorded data and 6 educational farms reported in the questionnaire (Figure 10). The map has been processed using the maximum number of messages for each site as a parameter for determining the value 1 (maximum) attributed to the cell on the raster-based cartography (cell 10 x 10 m). In this way, the maps of the different services are comparable.

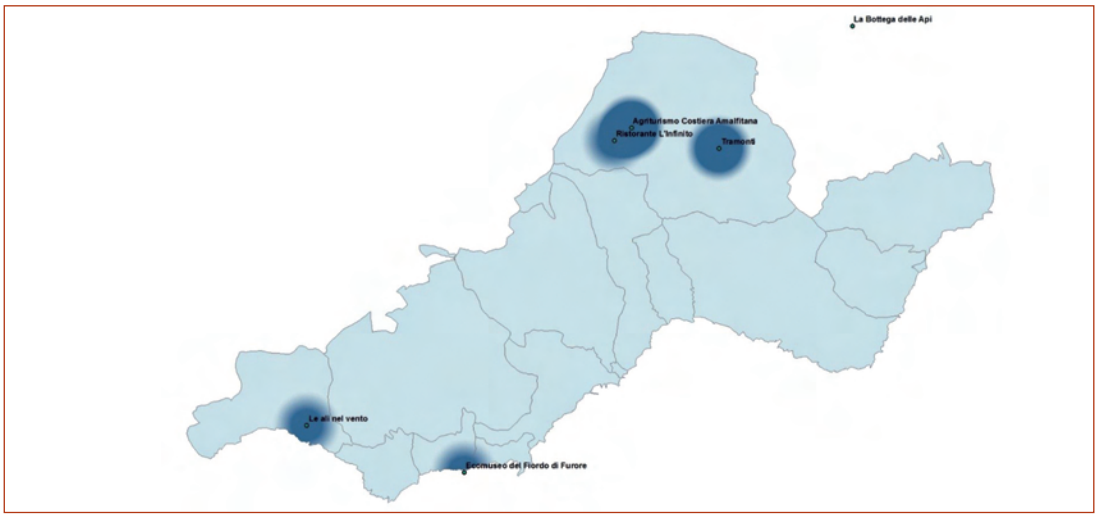

Figure 10 Density of educational scientific services in relation to the reporting frequency *Source: author processing*

Mapping the "Inspiration for art, culture and design"

The mapping of inspiration for art, culture and design (photographs, paintings, stories, representations of landscape design and craft) is made using the data acquired from the questionnaire related to traditional craft businesses in the area, resulting in a total of 14 reports and 13 craft enterprises of interest (Figure 11).

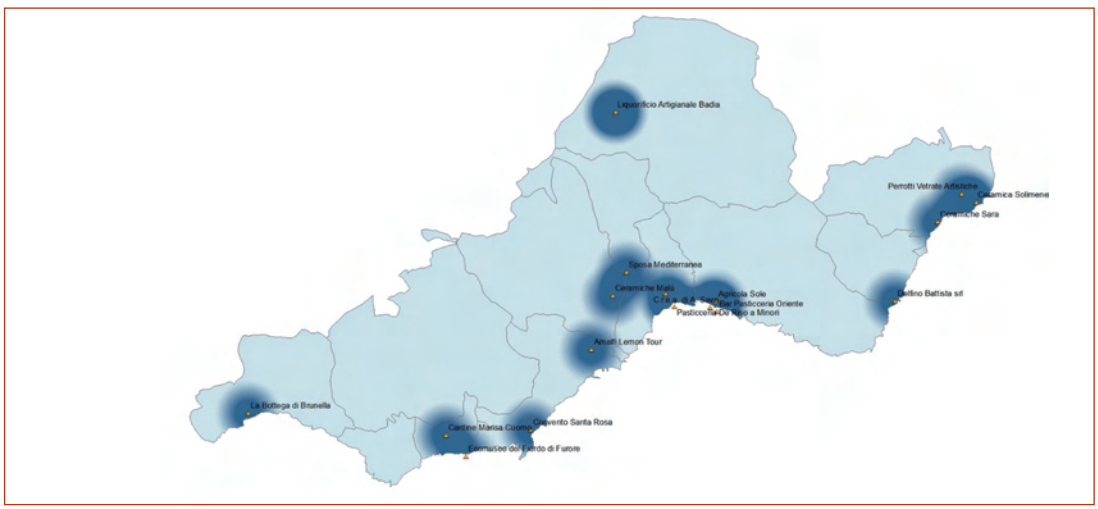

Figure 11 Density of Inspiration for art, culture and design *Source: author elaboration*

PROCESSING THE COMPLEX MAPS OF THE LANDSCAPE SERVICES: OBJECTIVE AND PARTICIPATORY MAPPING (ATTRIBUTION OF WEIGHTS)

The aggregated map of Cultural Services has been processed using spatial analysis in GIS. This methodology of spatial data analysis is based on the subdivision of the area in a grid of cells of defined size, in this case 10x10 m. The GIS analysis associates to each cell a class value (1 to 5) according to the reclassification operation on vector basis. The raster calculation function then allows to use the numeric values associated with each cell performing the algebraic sum and product operations of the space base. This allows to assign a weight to the services identified through the maps, using the values recognized through the questionnaire.

Through the GIS Tool "Raster Calculator", the maps of cultural services have been aggregated in the first instance in an "objective" way, by performing an operation of algebraic sum of the normalized values detected in each cell (Figure 12).

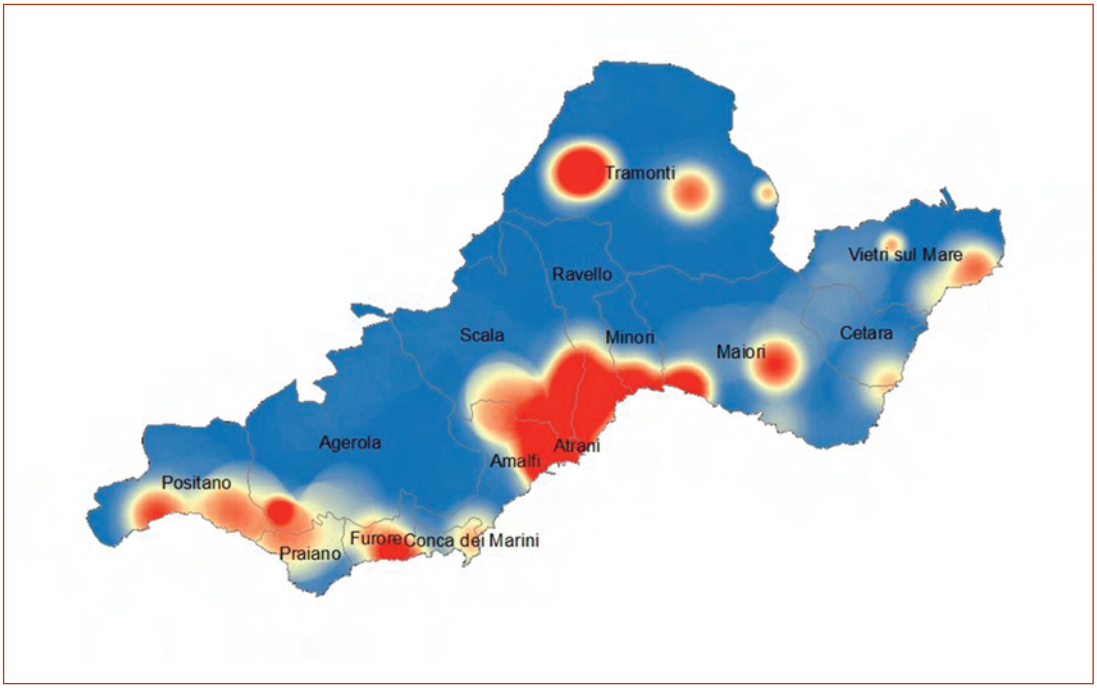

Figure 12 "Objective" map of cultural services
Source: author processing

The processing of the subjective maps (weighed) of cultural services has been realized using the weights assigned to the services in the questionnaire (cfr. Table 5) through the tool "Weighted Sum". Through this tool it has been possible to realize a map of cultural services which takes into account the subjective perceptions of the entire sample of respondents (Figure 13), subsequently reclassified for the construction of different intensity portions (Figure 14).

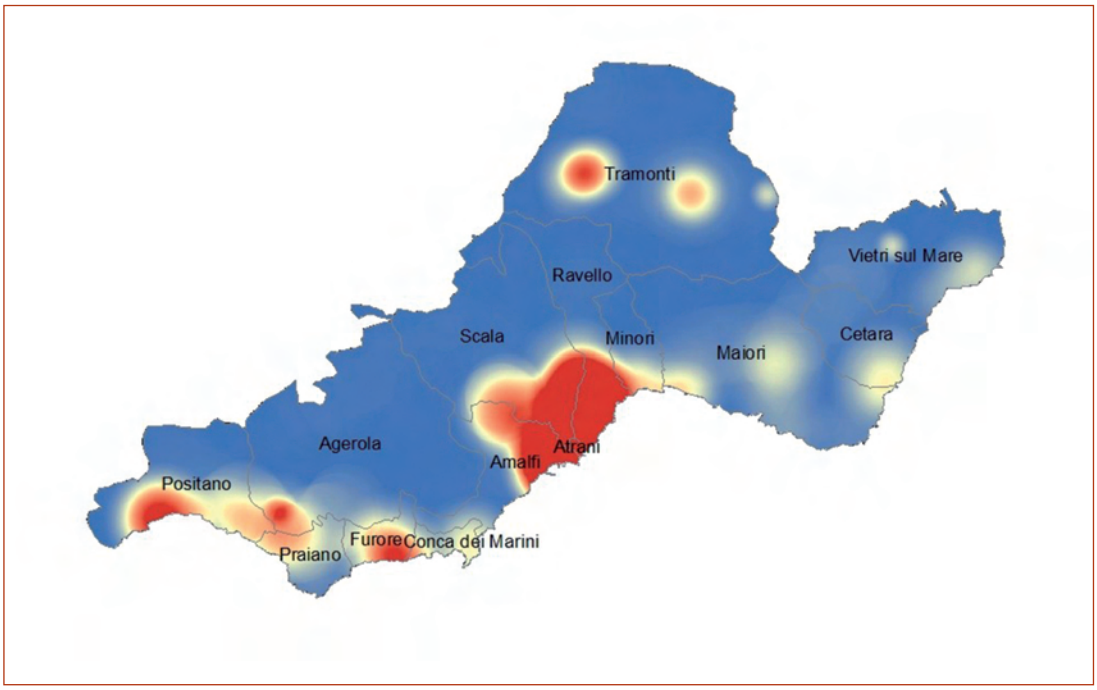

Figure 13 Subjective map of cultural services "weighted" according to the preferences and perceptions of the community
Source: author processing

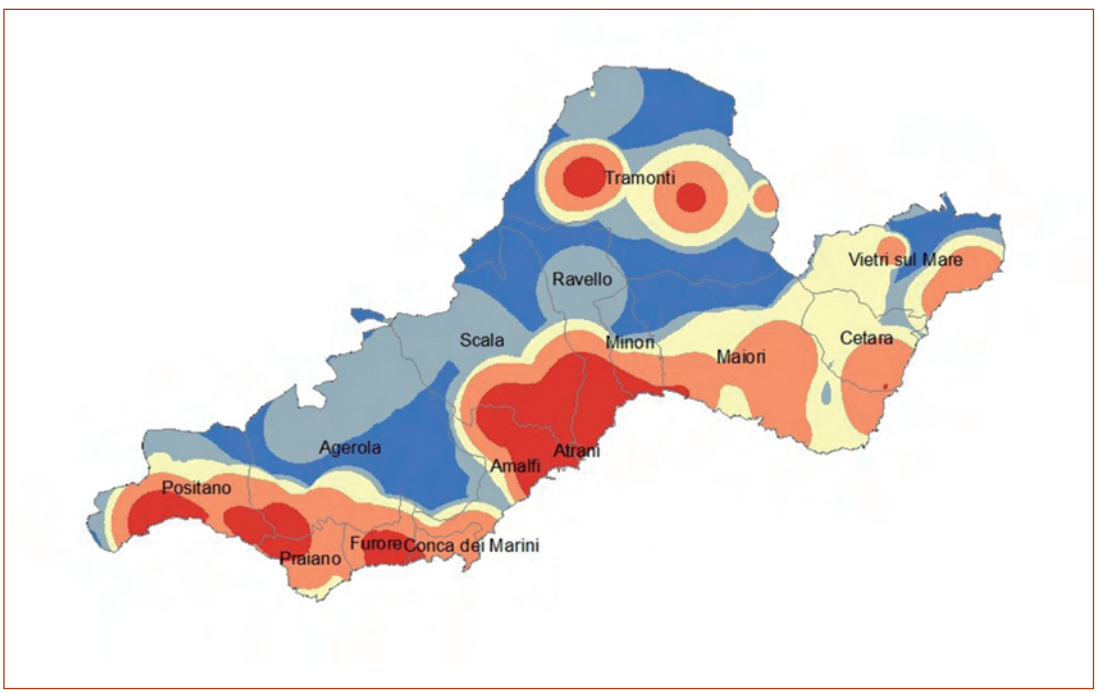

Figure 14 Thematic reclassification in 5 classes of density of cultural services
Source: author processing

DISCUSSION AND CONCLUSIONS

The need for an effective use of resources in the planning of actions to protect and enhance the cultural landscape recalls the need for integrated spatial assessment methodologies able to integrate the "non-expert knowledge" (Cerreta, 2010; Fagerholm, 2012), and to take into account the benefits enjoyed by stakeholders, relating what is being evaluated in a specific geographic location. Decision-making processes must be supported by evaluation systems able to manage the complexity of the landscape and define in transparent and effective ways the priorities for its transformation / conservation / management.

This research work has produced a specific knowledge of the terraced landscape that will enrich and complement the studies made in recent years in the field of international scientific research, using the knowledge acquired for the **construction of a multi-criteria evaluation framework** for cultural landscapes.

The **evaluation tools** are used as an **effective interpretative key**, **shared** by the community, in order to **identify areas in which cultural services are better provided and enjoyed** and at the same time to **encourage a "widespread" preservation of the cultural landscape**.

The **application to the case of the Amalfi Coast study** allowed to verify the validity of the methodology, its limitations and the possible developments in terms of scalability and adaptability to other contexts.

The results of the mapping phase have shown the ability to **locate and assess cultural services**. The services selected through the involvement of experts and local stakeholders represent a dynamic assessment and monitoring system, based on continuously updated data through the collaborative mapping tools. "The GIS is essential to analyze the wide variety of geographic data needed for the evaluation, while the multi-criteria methodologies allow the use of the weights to be assigned to criteria" (Sessa *et al.*, 2012). **The weights assigned to the indicators are integrated in the maps**, which become **synthetic interpretative tools of the complex relationships** between the value elements of the landscape.

Therefore, we can say that the integrated analysis of GIS and participatory tools has enabled the inclusion of **perceptual aspects** in the evaluation process, in order to define the territorial areas that are denser of cultural values. "The interrelationship between values, levels and methods is an interpretative key to understanding and evaluation, able to make use of normative and instrumental approaches" (Fusco Girard *et al.*, 2011b). The final maps obtained can be used to: (1) **highlight the areas of greatest conservation value**; (2) update knowledge **through collaborative mapping tools**, which on one hand allows the collection of data otherwise difficult to obtain, on the other hand increases the awareness of visitors and site residents. The proposed methodology, if applied extensively through the involvement of a statistically significant sample of the population, has been shown to be a useful tool for the integration of perceptions and preferences of stakeholders in decision-making and landscape planning. The transformations of the landscape, guided by a clear vision of values and services to be safeguarded and enhanced, can be implemented with a view to cultural and environmental sustainability of local development, affirming the right of communities to their own development, compatibly with the preservation of the natural and cultural values of the terraced landscape.

In conclusion, it can be said that the **proposed evaluation framework** is a useful **management tool for transformations of the terraced landscape**. In addition, the work opens up **future lines of**

research in building an Integrated Spatial Decision Support System based on the assessment of ecosystem and landscape services, able to integrate the preferences and needs of the community to build a "collaborative" desirable future.

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