Learning from tourists' preferences for urban planning

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Abstract

Evaluating environmental resources such as urban and territorial opportunities means understanding their value. Monetary values are not always able to synthesize the opportunity that such commons give to the development of individuals in urban space. We propose a replicable method able to inspect values that individuals give to different urban and territorial opportunities within a capability theory framework: a policy analytics method aimed to design legitimated public policies. This method is developed and illustrated with a case study of urban planning for the city of Alghero. The problem concerns the touristic temporal economy that characterize this territory and the tourists' needs and values that a development strategy oriented to deseasonalization have to consider. We analyse tourists' behaviour and learn their values using a multi-attribute value method. Furthermore, we define groups of tourists with similar values of urban opportunities, which consent to improve the set of relevant capabilities in a similar way. Finally some policy analytic's recommendations are given.

Keywords

Policy analytics, spatial multi-criteria analysis, Capability Theory, Multi-attribute Value Theory

Introduction

The aim of this work is to define a method exploring values of spatial environmental opportunities for different categories of individuals. Our purpose is to support the design of public policies legitimated by such categories, policies that take into account peoples' values and diversities. We propose a replicable method able to inspect values that individuals give to different territorial opportunities in space. We take care of "spatial values" given by groups of individuals to a location. According to Capability Theory (Sen

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1999), individuals choose to develop capabilities they value as important. Different individuals within the same territory can improve different capabilities with respect to personal characteristics and contextual factors. According to such theory, people should be characterized not by their personal characteristics or by their endowments in resources or their wealthiness, but by their behaviour with respect to such opportunities, as these capture their preferences and actions that norm the free choice of capabilities. Consequently, in this paper we aim defining groups of people with similar preferences (values) with respect to opportunities in space which consent to improve their capability set in a similar way. This implies studying both peoples' behaviour and the values that guide their choice in space. It also implies evaluating the whole set of environmental and territorial opportunities with respect to such values, in order to design territorial development policies focused to groups of people with similar values.

Evaluating environmental opportunities and cultural assets in space entails the definition of a demand curve of resources and services for which a real economic market (Dasgupta 2001; Robinson 2001; Haab et al. 2002) does not exist. Such values in space can be learned thanks to environmental economic models using revealed preferences or stated preferences. Among the methods we propose to use, we consider the multiple regression model and the multiple additive value function models (UTA family) in order to learn values from behaviours. UTA family methods to learn values from preferences are already used by (Lakiotaki et al. 2011) in order to build a movie recommended system to model users' preferences in order to identify the most preferred unknown item for every user. The method, which we claim of general validity, is tested with respect to the behaviour of a precise category of population, the tourists, and experimentally validated with data collected from a survey study in the territory of Alghero (Sassari, Italy).

In this paper we refer to the definition and classification of population given by Martinotti (1993) and Nuvolati (2003). They consider the community as the result of a "combination and integration of the needs, expectations, and behaviors of inhabitants, commuters, city users, tourists, and metropolitan businessmen" (the reader interested in this classification can see Nuvolati (2003)). Such groups of population use the city and the services in different ways, sometimes mixing the needs and uses that characterize a single group. For this reason there are authors (see, for example, Cannaos (2001)) that define tourists as a category of the city inhabitant with respect to the different needs and values of the travel. Cohen (1974) defines the characteristic of this type of inhabitant, stressing the different forms that characterize the contemporary tourism, ranging from simple excursion to complex world tours, and the different components and needs that distinguish the groups of tourists (religious trip, health trip,...). For Cohen (1974) the tourist is a "temporary traveller, travelling in the expectation of pleasure from the novelty and change experienced on a relatively long and non-recurrent round trip".

Evaluating values in space entails also to understand how values are distributed in the territory in order to build maps helping in decision making . A more complex decision spatial map will be the one that takes into account not only values of spaces (values of different categories of attractions/opportunities) but also the direct relation between individuals and space (values of the characteristics of the space). Multi-criteria decision making methods, and especially the value theory approach are suitable in spatial planning problems, especially for the definition of public policies. Spatial processes are indeed characterized by multiple elements that shape the processes and relations among the populations. With this reference we claim the necessity to develop the integration of that multi-criteria decision making methods with Geographic Information Systems (Malczewski and Rinner 2015) in order to build new Design Multi-criteria Spatial Decision Support Systems (o Design Planning Support Systems)(Design-PSS). This topic is a new challenge for the policy making field based on the assumption that design of new policies is above all linked to creativity and cannot be limited to deterministic methods. A Design-PSS is a method able to unveil unprecedented factors which demonstrate to play an important role with respect to the observed phenomenon. Design is associated with giving form to some concrete response to a need or a problem (Alexander 1982). The difference between a Planning Support System (PSS) and a Design-PSS is that the second goes beyond the analysis and assessment of space, thus providing an analysis method that stimulates a change. This change can be either with respect to the criteria that improve policy analytics (Marchi et al. 2016), or with respect to the definition of new solutions to the problem. On this regard, a Design PSS is supposed to evaluate a context according to a set of defined criteria as well as to reveal new unprecedented criteria. Similarly, it should evaluate a set of alternatives, as well as to suggest new innovative ones. Innovative alternatives consist in of a new set of actions or in different combination of actions unexpected at the beginning of the policy cycle.

In the following paragraphs we first describe the problem in the touristic context of Alghero city, then we explore the literature in order to select the methods more suitable for the analysis of environmental values in space for the touristic population. In the fourth section we illustrate our method with an application to the case study, finally, some policy analytic's recommendations are given.

The problem. Alghero case study

Alghero is a city of about 40.000 citizens in the north east coast of the island of Sardinia (ITALY), characterized by an economic dependance from the touristic season for the development of the territory. Data collected by the observatory of tourism show how the city experience each year about 800.000 occasional "population of visitors", among city users, tourists, and business man with a constant growth in the last years (in 2014 there was a growth of 11 %) (Cannaos et al. 2014).

These "inhabitants" are concentrated above all in the months of July and August, with officially data that point out a pick of 12.000 occasional population during the mid-August holiday. Whereas the months of June, September and October register important numbers of occasional population (more than 100.000 inhabitants per month), that choose to spend from 3 to 8 days in the city, fewer are the numbers of visitors that choose to stay in Alghero for just a weekend between November and April (an average of about 10.000 per month). These data stress the seasonality of this tourist economy and emphasise the necessity to design public policies oriented to a deseasonalization in order to foster a sustainable development of the territory.

Looking at the low season period trends we can frame better the problem. Data collected in October-November 2014 (Blečić et al. 2016) show that this seasonal population usually travels in couple (46,67 %) or alone (17 %), while groups of families, couples with children and groups of friends cover each about a 9 % share of the sample. They choose to stay in Alghero for the favourable climate, the possibility to relax and enjoy food and wine traditions in a environment of high quality. This demonstrates the attractiveness of this location despite the end of the bathing season. A previous work (Blečić et al. 2016) shows that the main places of interest are concentrated between the historical centre and the waterfront. More precisely it is possible to distinguish some historical and archaeological elements located in the city centre and in the whole territory of the city, like the cathedral, the bastions, and the historical settlements located near the city centre linked to the Nuragic civilization, as well as the most recent settlements founded during the period of land reclamation characterized by a rationalist architecture (like Fertilia and Santa

Maria). Environmental resources (both local and territorial) are considered indispensable destinations also in the low season period: the beach of the city (Lido), the Nettuno caves and the numerous beaches and panoramic viewpoints that surround the gulf are just some examples of such places. Finally there are some cultural elements (like the civic theater, the museums, . . .) and the leisure (waterfront, public gardens, the harbor, . . .) and food services (the civic market, the typical restaurants, . . .) that are important attractors for the tourists.

An economic development heavily exploiting tourism can bring both positive and negative consequences. A "temporal" economy risks to influence the territorial development, as well as the services and opportunities which need to be strategically improved in order to meet the will of the different populations that live the city (Martinotti 1993). A strategic development of a territory needs to consider all the groups that live in the city, especially the needs of those groups that mainly meet the development strategy of such territories. Needs and values of tourists vary, among others, according to individual characteristics and interests (Kellner and Egger 2016), to the spatial distribution of urban and territorial activities and to the quality of the accessibility in the city (Blečić et al. 2015a). We already know (Blečić et al. 2016) that young people spend relatively less time in the city centre, and appear to be more interested to beaches and the surrounding territory, adults are used to frequent the historical centre and the beaches, while elderly people concentrate their time in the historical centre and appear to be less interested in the beaches.

Therefore, a public policy should consider visitors' values (in this paper we use the terms tourist and visitor as synonyms), needs and preferences in order to strategically improve the quality of life of the territory in terms of the capability set offered to the whole population. A policy attentive in different peoples values can help in developing personal urban capabilities with the improvement and extension of such urban opportunities that are most valued by this occasional population (in a capability framework, "what people value" (Sen 1999)).

Background

Evaluating environmental resources and cultural assets for which a real market does not exist is a well known problem in literature (Dasgupta 2001; Robinson 2001; Haab et al. 2002). For environmental resources, such as the urban and territorial opportunities, it means understanding the value of these commons and public goods even if is not a monetary one (Robinson 2001). Several methods help in the analysis of values of environmental resources considering revealed preferences or stated preferences that allow to define the demand curve of an hypothetical market.

Revealed preferences can be learned analysing the past behaviour of a decision maker. The method of the hedonic prices (Rosen 1974; Bartik 1987), for example, uses as proxies the purchase of market goods that reflect the price of the good (not exchangeable in the market) in a real market. For example we can consider just the prices of the houses in the city in order to understand the value of the different areas in terms of quality of urban life (Dasgupta 2001). However, the method of hedonic prices has several problems due to the consideration of a perfect market that reflects in the prices the willingness to pay for the different characteristic of the resources. Another example is that of travel costs (Hotelling 1949; Smith 1971), method usually used to estimate economic values associated with the ecosystems or sites that are used for recreation.

A second family of methods estimates the preferences of stakeholders or decision makers from stated preferences that are declared with respect to a future scenario proposed by the interviewer. The main aim is to inspect the hypothetical value of the good in a future real market. Contingent valuation (Carson et al. 1994; Ciriacy-Wantrup 1947; Cummings et al. 1986; Mitchell and Carson 1989) and conjoint analysis (Louviere 1988) are some of the methods most used in such cases. For the contingent valuation (Carson et al. 1994; Ciriacy-Wantrup 1947; Cummings et al. 1986; Mitchell and Carson 1989) the analyst provides to the interviewed an hypothetical environmental scenario (caused by a policy or a intensive use of the resources) and asks the willingness to pay or the willingness to accept a compensation in order to avoid or favor the realization of such scenario. Conjoint analysis (Louviere 1988) is a similar method that decomposes into utilities or values the set of individual evaluation (or discrete choices) of a multi-attribute alternative. This family of methods defines a set of possible alternative environmental scenarios and their monetary cost and requires the stakeholder to rank, rate or evaluate such different options. This implies that the interviewed has to know perfectly the good and the means of payment, and that he really imagine the possibility that this scenario will happen and that choice can modify it. Furthermore it implies the existence of these new markets for a check. For these reasons Sen (1995) stress that the problem in defining values with such a method is often due to the protocol used to inspect people preferences that does not allow to identify independent preferences and the preferred alternatives.

Although such methods are frequently used in environment economics in order to evaluate an effect of a project in space (Pearce 1998), they have been criticised due to the economic vision of the space (Sen 1995), which is not representative of the whole value of such resources and assets. They consider behaviours and preferences as explicable by normative models that look at people as rational consumers choosing to do something in the city thanks to an economic offer. Such a consumer is a standard one, acting in the city just following economic rules. All such methods are not able to inspect subjective values given by individuals to the city. With reference to such critiques we note Sen (1995)'s work about environmental evaluation and social choice in which he argues the necessity to consider the individual not just as an operator in a market, but as a citizen that judges alternatives from a social perspective, including (among others) his wellbeing.

Accordingly, we consider the individual as a citizen, with his\her preferences and subjective values(Keeney 1992). Especially, we are interested in values in space in terms of capabilities (Sen 1999), those capabilities that people value as important, which we name as "relevant capabilities". What we claim is the possibility to use capability theory in order to analyse how people value environmental resources and assets in terms of urban and territorial opportunities for the development of the individual capabilities in the city. The use of the capability theory in order to assess the quality of life in cities and territories is a new field of study, developed only in recent years by few studies (Blečić et al. 2015b,a, 2013; Frediani 2015). We contribute by proposing a method analysing the individual values with respect to environmental opportunities, in terms of preference of choice of different "relevant urban capabilities".

Capability Theory

Capability theory (Sen 1999) goes beyond the economic concept of wellbeing, stressing the importance of evaluating not primary goods or utilities, but substantive freedoms (named capabilities) to choose a "life one has reason to value" (Sen 1999). The concept of capability entails two components (Blečić et al. 2015b): the "ability" of an individual with respect to his personal characteristics, and the "opportunity" given by the socio-environmental context to freely access the endowments (set of resources and assets). The capability set of an individual depends both on individual and contextual conditions and commodities. The aim of such theory is to evaluate the real advantage people have to choose their beings and doings thanks to the conversion of such commodities and conditions in advantage for their development (Figure 1).

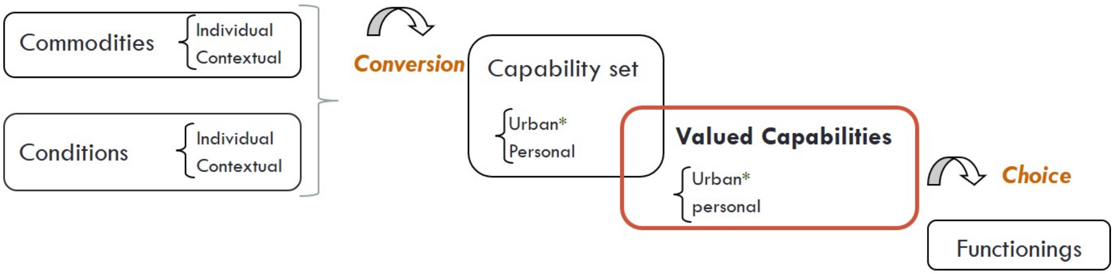

Figure 1. Conversion process of commodities in capabilities in a particular social and personal context. Inspired by Robeyns (2005); Blečić et al. (2015b)

In that conversion the human diversity is fundamental as the notion of advantage deals with a person's real opportunities compared to others (Sen 1999). Individuals can develop different functionings (things a person may value to do or to be) and capabilities (the combination of functionings) with respect to personal and socio-environment factors (see the Figure 1 for the conversion process). The same person can convert the same asset differently in different spaces, in the same way two different persons in the same place may convert the same asset in different functionings. According to Blečić et al. (2015b,a, 2013), there are particular sets of capabilities that are influenced by urban and territorial factors and social context that we name "urban capabilities". With respect to these, we are interested to inspect people preferences of "relevant urban capabilities": the set of "urban capabilities" that people value as important. Sen (1999) claims that each group of people should itself choose which capability set to develop in functioning with respect to their values. We propose a method to evaluate such "relevant urban capabilities" and to group people with similar abilities and opportunities, but above all, with similar values. Finally we project these values in space and define a geography of "relevant urban capabilities" for different categories of people.

In the following paragraphs we describe the methods most commonly used in the literature to inspect the environmental preferences and values of the population that interest this study, the tourists, starting from people behaviour in space. Then we explore some alternative methods that can be useful in order to analyse subjective values in environmental studies. These two fields of studies will be used for the development of our method.

Tourist behaviours in space

The analysis of tourists' behaviour in space is a part of the "time geography" field (Shoval et al. 2015; Herstraand 1970). Time geography focuses on the constraints on human activities in space and time (Miller 2005). It deals with the relationship between space and time, considering the constraints and trade-offs for the development of activities given a limited time. Methods surveying and analysing spatio-temporal behaviour are highly developed in transportation research and in social sciences in general

(Kwan 2002), however little attention has been paid to the analysis of spatial and temporal behaviour of tourists (Shoval and Isaacson 2010). This is due, essentially, to the difficulty to gather data.

The most common way to study tourists' behaviours in time and space are various methods of "time-space diary" (Shoval et al. 2014) that provide a systematic record of the way in which individuals occupy their time in space (Anderson 1971). Systematic studies taking advantage of the technological developments offered by the high precision position tracking are still relatively few. New possibilities have arisen by the development of automated tracking, above all the satellite-based (e.g. GPS) technologies for automatic position tracking with high time and spatial resolution (Shoval and Isaacson 2007, 2010).

In recent years scholars have started to break ground in this specific domain of applied research, experimenting and exploring advantages and disadvantages of satellite-based positioning technologies for the study of tourists' spatio-temporal behaviours (Shoval and Isaacson 2007, 2010; Shoval et al. 2014). Different methods have been reported for tracking tourist spatio-temporal behaviours by Kellner and Egger (2016): direct observation of tourists' activities, with interviews or remote observations; time-space budget techniques (Pearce and Pearce 1988) which analyse tourists' activities within destinations by using diaries, questionnaires and interviews; video-based tracking analysis, used to track tourists movements through video footage; smartphones with apps using positioning systems; specialized GPS tracking devices; land-based tracking systems that collect data thanks to radio technology.

Among the different tourist's location, many studies focus on particular urban areas or activities that have a clearly defined entry and exit point, such as natural parks or historical centres (Shoval et al. 2014). Also many urban contexts have been analysed, among which Rome Calabrese and Ratti (2006), Lago del Garda (Bruno et al. 2010), Canberra and Sydney (Edwards et al. 2009), Salzburg (Kellner and Egger 2016), Bilbao (Aranburu et al. 2016), Hong Kong (Shoval et al. 2015). On the other side, there are studies that attempt to analyse tourist behaviour at a very large scale (e.g. on the national scale, by using mobile phones data (Ahas et al. 2007).

Different statistical and visualisation techniques can be used in order to summarize the analysis of such data. Frequently spatial temporal data are used to describe the tourists track frequency in maps. Sometimes these spatial maps combine information collected through questionnaires. This allows to link spatio-temporal behaviours to a specific tourist category of population with classical statistical methods (age pyramid, employment,...). Furthermore, there are studies trying to predict visitors whereabouts, how long they will stay in a place, or carry out a specific activity (Chhetri et al. 2010), and studies that analyse the sequence of movements in space for different groups of people (Shoval et al. 2015). Particularly, Shoval et al. (2015) use a sequence alignment method to inspect which type of location are visited and in which order from different groups of visitors. Only few studies try to inspect the relation between space and the tourists' behaviour. One example is given by Aranburu et al. (2016) that use network analysis in order to determine the central places of Bilbao and analyse the spatial interaction between cultural sites starting from the GPS network points of interest.

However, all such studies analyse data in order to inspect behaviours in space, the concentration of individuals in particular areas and the possible relations among individuals and space. These studies analyse what people actually do in space, without considering what people can do thanks to space configuration and activities (the capability set) or how people value a different space configuration (in case of a new project). Whit this reference, we claim the importance to consider also subjective values in space in a value theory approach (Keeney 1994).

Values and preferences: multi-attribute value theory.

Understanding how space and the environment influence people's values is one fundamental step in order to design legitimated public policies. Values are principles assessing the desirability of any possible alternative or consequence and define all that we care about in a specific decision situation (Keeney 1994). Alternatives are important just because they are means to achieve values (Keeney 1994). According to the capability theory framework, what is interesting are not the means but the opportunity given by the means, the opportunities that the alternative offer to people.

When we value an alternative we consider, possibly involuntarily, a multi-attribute problem, characterized by different dimensions not easy to synthesize and to compare among them. Multi-criteria decision aiding methods (Belton and Stewart 2002; Bouyssou et al. 2000; Figuera et al. 2005) can help environmental and urban planning (Beinat 1997; Lahdelma et al. 2000) to inspect and synthesize values for different space configurations (alternatives) and to manage decisions with conflicting and multiple objectives.

Withim Multiple-criteria Decision Analysis methods (Belton and Stewart 2002; Bouyssou et al. 2000) we focus on the multi-attribute value theory approach (Keeney and Raiffa 1976; von Winterfeldt, D. and Edwards 1986) which consents to evaluate alternatives under multi-objectives with respect to people's preferences. Multi-attribute value theory is a method representing preferences, but also a way to measure preferences in terms of their intensities (how much A is better than B?). This is a unique feature since it allows to compare decision makers with respect to their values. This unique feature allows us to generate groups of people with similar values. The value-based information helps to design and plan public policies with respect to what the inhabitants and stakeholder want. Moreover, this decision analytic methodology consents to measure individual preferences in non-monetary terms, fostering its use for the analysis of environmental values (Ananda and Herath 2003; Martin et al. 2000; Beinat 1997; Ferretti et al. 2014).

The multi-attribute value theory approach associates a "score" to each alternatives with respect to a function that represents the subjective difference of values on an interval scale (for a given decision maker or user) (Keeney and Raiffa 1976). This method generates a preference order among alternatives and helps to choose the one that best fits with the values of the decision maker. Practically, it scores the alternatives (from 1 representing the best performance possible to 0 representing the worst one) with respect to the different advantages (in a capability framework) given to the decision maker. Considering the nature of the method, measuring values acquires a fundamental role in that decision process. In order to understand the values behind this decision process, we can consider that the decision-maker tends to maximise his value function (Bouyssou et al. 2000). This means that the decision maker evaluates all the alternatives taking into account his preferences and value scale. For this reason, if we analyse values and preferences we can replicate the decision process of an hypothetical decision maker and understand some of the factors linked to the legitimation of a public policy.

To inspect such values we choose to build an additive value function representing the preference of the decision maker and their differences. Two methods may be used in order to assess this function: a decomposed scaling or an holistic scaling strategy (Beinat 1997). For the first one the value function is composed by assessing separately the set of marginal value functions, then an additive value function is built taking into account the trade-offs among the different attributes these being considered commensurable. The holistic or indirect strategy is based on overall value judgements of multi-attribute profiles and a successive estimation of the marginal value function with fitting techniques (regression models, ...). It is a representation of the set of preferences and values that the decision maker uses to make a choice. The reader interested in deepen these methods can look at the Beinat (1997)'s work that offers a systematic review of existing approaches used to build the value functions with both such strategies.

When we deal with a public policy we are interested in the preferences of the inhabitants in order to build legitimated policies. However it is impossible to interview all the inhabitants, even if we are interested in all their preferences. For this reason we claim that holistic or indirect methods are more useful in analysing values in space and unveil the desirability of a possible set of future public policies.

In this paper we estimate value functions from holistic judgements deducted from people behaviour using multiple regression methods and linear programming techniques (the UTA+ method (Kostkowski and Slowinski 1996)). We claim that this method is more useful for our problem as it allows to investigate indirectly large sets of preferences considering at the same time for example behaviour or judgments. On the contrary, the decomposed scaling needs a direct relation among each decision maker.

The Method

In this section we propose a policy analytic method aimed to define groups of people with similar preferences and values in space. A method aiding in design public policies able to improve the capability set of people with similar preferences, values and needs.

We present a multi-criteria model that combines preference learning methods with unsupervised machine learning (Fürnkranz and Hüllermeier 2010) in order to estimate parameters for the best territorial offer for each group of people. The method is composed of different phases as we can see in Figure 2:

1. Survey and data collection. The survey is aimed to directly collect data useful for the analysis. This step is always essential if we want meaningful data, however, is not always possible to make a survey as it is very expensive (in terms of temps and money), so the analyst have frequently to deal with secondary data.
2. Multiple-criteria decision analysis of preferences. In this phase we define the set of criteria that describe our problem and analyse the preferences and values of people involved in the survey.
3. Selection of relevant factors for personalization. This phase allows to simplify the model removing factors that, even if we consider as important, do not change the final result. It is composed by a (1) cluster analysis of the utility functions and (2) a rough set analysis
4. Cluster analysis: profiling. The final phase consent to group people with similar values and preferences and give us the possibility to propose them new alternatives of development.
5. Recommendation. Final recommendations consent us to give useful information to the policy maker for the design of new policies.

In the following paragraphs we'll describe item by item in detail.

Data collection: the survey

In this paper we use secondary data collected by the author for the "urban quality of life of tourist" project, aimed to analyse tourist's quality of life in a low season period (Blečić et al. 2016). We analyse the tourist population in Alghero city during the 2014 touristic low season (October-November), considering that Alghero's peek period is the summer season with highest tourist concentration between

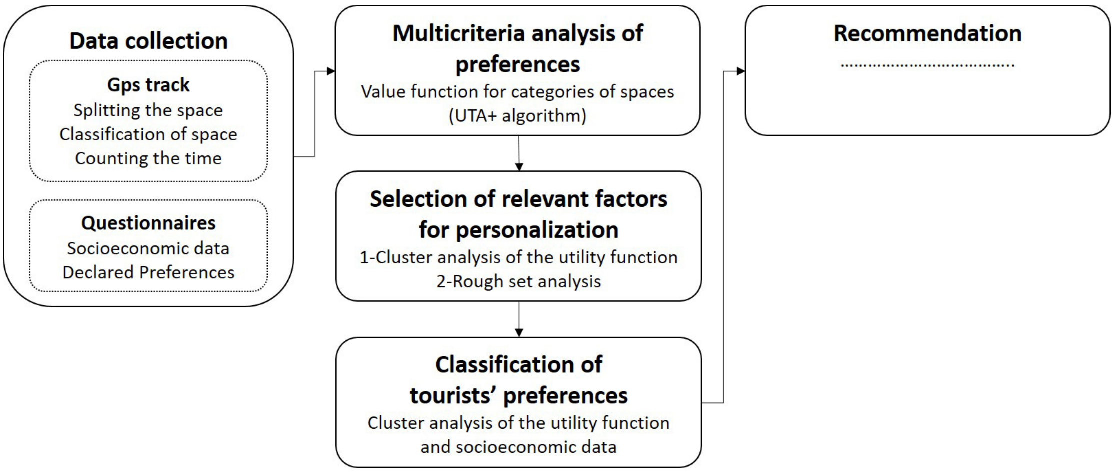

Figure 2. The method

July and September. We choose to collect data in this period because we want to catch urban limits and opportunities due to the reduction of urban activities. We also expect to catch significant information for the design of a public policy aimed to deseasonalize this trend. Two types of data were collected in the survey: interviews inspecting expectations and degree of satisfaction as well as GPS movement tracking exploring tourists' movements in the territory. For more information about the survey method see Blecic et al.'s work Blečić et al. (2016).

Especially, we dispose of 75 questionnaires representing 225 tourists T described by a set of attributes A.

$$A = \{gender, age, country, level\_of\_study, profession, willingness\_to\_pay\} \tag{1}$$

For each tourist we know a set of declared preferences. The tourist was asked to order a set of criteria with respect to their importance (given an evaluation scale) for choosing Alghero as destination. Let's have for each tourists' criteria $zt \in Zt$ a value $n \in \xi$ with $\xi\{1, 2, 3, 4, 5\}$

$$\begin{aligned} Zt = n\{&Economy, Environment, Weather, Food, Culture, Recreation,\\ &Entertainment, Study, Work, Relax, Friends\_and\_relatives, others\} \end{aligned} \tag{2}$$

Moreover, we know the tourists' paths in the territory, in a space described by Coordinates and Time. Let S denote the set of possible coordinates and τ the set of possible times. A path is a set of points $P \subseteq S \times \tau$.
Finally we define a set of Categories of attractions $C \in S$ that a tourist can choose in Alghero city (Table 1). These Categories are chosen considering the main places of interest as defined from a previous study (the reader interested can found more information in Blečić et al. (2016)).

In order to have coordinates divided in categories of attractions we did a spatial classification analysis of coordinates data (Figure 3). The main phases are summarized as follow:

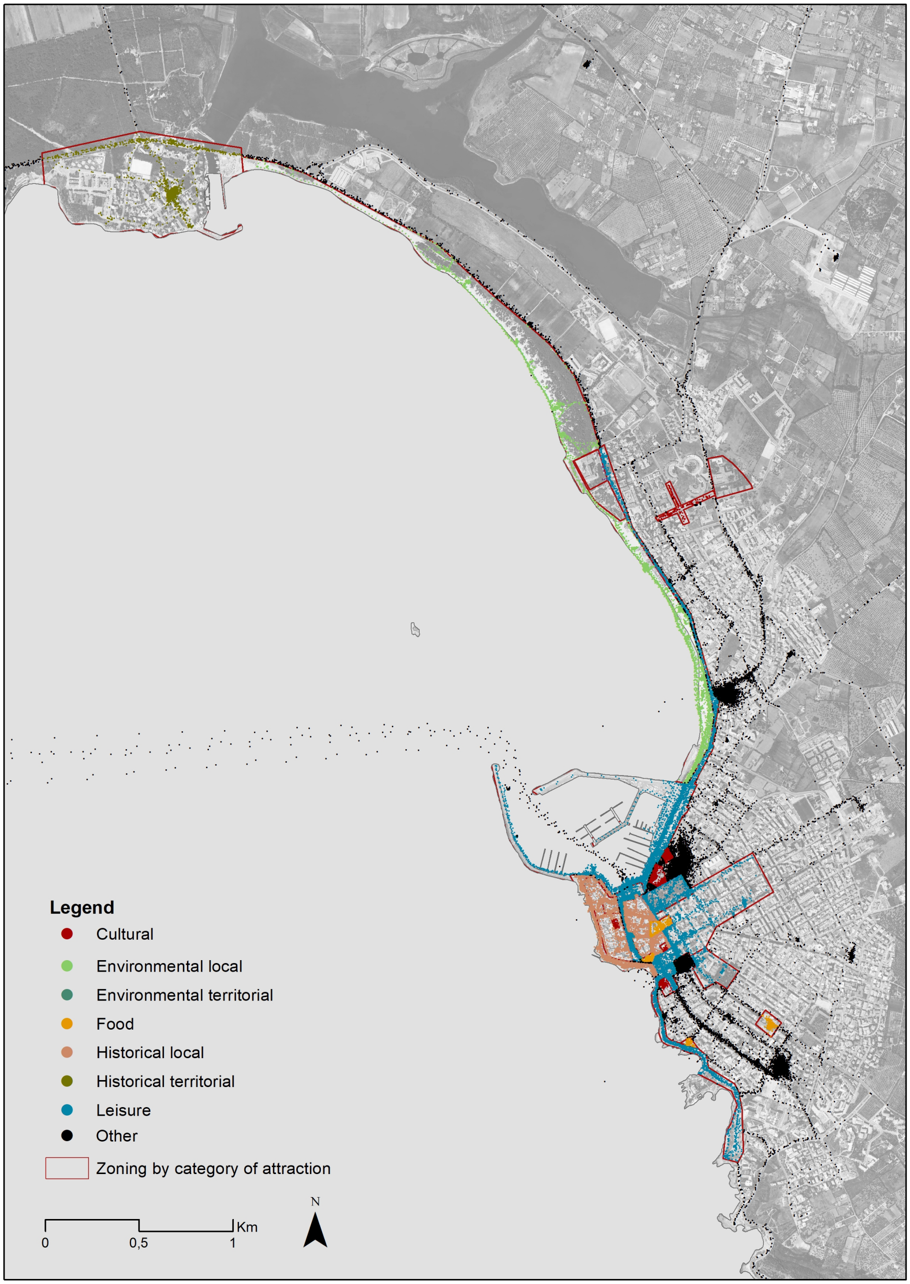

Figure 3. Classification of paths with respect to categories of places

Categories of attractions	**Attractions**
Environmental elements (local)	Lido, M. Pia, ...
Environmental elements (territorial)	Grotte di Nettuno, Punta Giglio, Spiaggia del Lazzaretto, ...
Historical and archaeological elements (local)	Cattedrale,Bastioni,Historical centre, ...
Historical and archaeological elements (territorial)	Fertilia, Castelsardo, Stintino, nuraghe Palmavera, ...
Cultural Elements	Theater, Cinema, Museum, ...
Food services	Restaurants, Market,...
Leisure	Waterfront, Public Gardens, Harbor, ...
Other	Stay in the Hotel, friends' home, Route from one place to another, ...

Table 1. Categories of attractions

1. Split the space. Subdivide the territory in different places p. Alghero territory was divided into polygons, with each polygon representing a single Category of attraction (Figure 3). Polygons represent specific environmental, historical and cultural attractions (Table1), tourist services and the major urban shopping and dining districts commonly frequented by tourists.
2. Classify spaces. Classify each attraction in a Category c. Let $C = \{c_1, \ldots, c_8\}$ denote the set of categories of attraction.
3. Count the time. For each tourists' path we analyse the time spent for any category of attraction c. For each tourist t we analyse how much time ($i^t \in \mathbb{R}^+$ the total number of seconds) he has spent on his trip in the different category of attraction c. The time spent in any category is given by the sum of the different ranges of time in this category of place $x^t(c_v)$. Finally we consider that each tourist has 15 hours to spend in a day.

Starting with these considerations we define a vector path $x : C \to R^+$ as a function that maps each category of attraction to a number of seconds and $X = {\mathbb{R}^+}^C$ the set of all possible vector paths. We associate to each tourist $t \in T$ a vector path x^t and consider that among all the vector paths, the tourist chose a path with respect to a preference relation. A preference relation is given when the tourist can freely choose a path rather than another whit respect to his\her individual characteristics (age, gender,...) and to his\her personal (income, goods,...) and spatial resources (means of transport, spatial distribution of activities, ...), expanding his set of urban capabilities (Sen 1999; Blečić et al. 2015b).

Our objective is to associate to each tourist $t \in T$ a preference relation S_t which represents, according to our model, the way the tourist evaluates the possible paths in the Alghero territory, i.e. the way the tourist values the space. This preference relation can also reveal important elements for the design of new paths with respect to the demand of opportunities of the tourist population in Alghero.

Multiple-criteria decision analysis of preferences

This first phase aims to define people's preferences with respect to the criteria selected for the evaluation of space. We consider that each tourist is a decision maker needing to be aided in order to understand his priorities and values in terms of what he can do in the Alghero territory. What he\her can freely choose to

Summary of data	**Description**
T	Set of tourists (t a tourist)
Z	Set of aspects on which tourist has declared a degree of interest (Zt)
$d^t : Z \to \{1,2,3,4,5\}$	A function such that $d^t(z) \in \{1,2,3,4,5\}$ indicates, for tourist $t \in T$ and aspect $z \in Z$, the degree of interest on aspect z as declared by t
$i^t \in \mathbb{R}^+$	Intensity corresponding to t: the total number of seconds tourist t has spent on his trip in the different categories of space.
C_V	The categories of places in Alghero *that can be visited*, thus *including* staying home.
$x^t : C_V \to \mathbb{R}^+$	The vector path chosen by tourist t that associates a number of seconds to each category of place. By definition, $\sum_{c \in C_V} x^t(c) = i^t$.

Table 2. Summary of data

develop in terms of urban capabilities thanks to the urban environment and his\her personal caracteristics. The analysis of space can be then intended as a multi-criteria decision making problem that aims to rank a set of finite alternatives, i.e. all the possible paths offered by the territory and valued as important by the tourist. In that model the criteria are represented by the different opportunities given by the territory, and are described by the intensity of time $i^t \in \mathbb{R}^+$ that each tourist has spent in each category of place C_V.

As stated above, preferences and values can be learned with different methods. Here we propose two methods to estimate the value functions from holistic judgements deducted from people behaviour. The first one uses the multiple linear regression to define the correlation between variables and the relative trade-off between criteria, and the second one uses the UTA (Jacquet-Lagreze and Siskos 1982) method that elaborates the problem as a set of additive utility functions.

Unlinked Multiple linear regression

We start analysing values with the multiple linear regression model, using the .R software. Multiple linear regression attempts to model the relationship between two or more explanatory variables (independent variables) and a response variable (dependent variable) by fitting a linear equation to observed data. In our model the set of aspects on which tourists have declared a degree of interest Zt are the explanatory variables of the intensity of time $i^t \in \mathbb{R}^+$ spent in a category of place C_V. This means that we have two dependent elements that are influenced by the declared preferences of people. For this reason we cannot use a standard multiple linear regression model.

In order to directly predict the interest in spend time in the different categories of space, we develop an unlinked multiple regression model aimed to investigate the relation among the declared preferences $\{1,2,3,4,5\}^Z \times \mathbb{R}^+$ and the time spent in different categories of space $i^t \in \mathbb{R}^+$ ${\mathbb{R}^+}^{C_V}$. We consider intensities with respect to the effective time spent outside by a tourist, reason for which we normalize intensities with respect to the time spent in each category of place (without the time spent in the "Other" category).

Results show low relations between the dependent variable and the independents ones. For example, the regression model between declared preferences $\{1,2,3,4,5\}^Z \times \mathbb{R}^+$ and the time spent in environmental local places $\mathbb{R}^{+EnvLocal}$ shows a R-squared of 0.25 and a low significance of independent variables (the $ttest$).

We also develop a second model isolating the set of aspects $z \in Z$ that are more relevant (environment, health, food, events, family) (see Table 3), but also in this case, even if we have lows p values (indicating a correlation), we obtain low significance value that shows another time a low R-squared of 0.21. This means, the model explains 21% of the tourist t choice to spend a range of time in the Environmental Local Category of place.

	Estimate	Std. Error	t value	Pr(>|t|)	signif.
(Intercept)	0.31645	0.09119	3.470	0.000953	***
environment	-0.03112	0.01751	-1.778	0.080370	.
health	0.04551	0.01988	2.290	0.025463	*
food	-0.07062	0.02216	-3.187	0.002249	**
events	0.06045	0.02723	2.220	0.030053	*
family	-0.06162	0.02021	-3.049	0.003375	**

Signif. codes	$0 *** 0.001 **0.01 * 0.05.0.11$
Residual standard error	0.1916 on 62 degrees of freedom
Multiple R-squared	0.2126, Adjusted R-squared: 0.1491
F-statistic	3.348 on 5 and 62 DF, p-value: 0.009678

Table 3. Unlinked regression. Example by Environmental Local places

These results show that this model is unable (as it stands) to simulate and predict behaviour in space. This may be due to the necessity to define unlinked models that are able to predict only a part of the values that explains people behaviour. Moreover, according to capability theory declared preferences are unable to explain the choice of a behaviour (functionings). We need to study differently the values \preferences used by people to choice among their capability set the developed functioning.

UTA method

In our opinion, in order to learn preferences through examples legitimated by the decision maker, we have to use a method that disaggregate preferences. For this purpose we considered the UTA (Additive Utility Functions) family of methods. As already stressed in this paper, it also allows to compare the values among decision makers, a known problem that affects the public policies having to deal with multiple stakeholder.

UTA are a family of multi-criteria analysis methods aimed to evaluate alternatives thanks to a set of value or utility functions adopting the preference disaggregation principle. UTA was originally proposed by Jaquet-Lagreze and Siskos Jacquet-Lagreze and Siskos (1982) and then developed in different forms (Siskos et al. 2005). The method builds a set of additive value functions from a ranking on a reference set A given by the decision maker. It uses linear programming in order to estimate the family of the utility functions with the minimum possible error and to compute the optimal set of functions as consistent as possible with the given preferences .

The criteria aggregation model in UTA is an additive value function (Jacquet-Lagreze and Siskos 1982):

$$u(g) = \sum_{i=1}^{n} p_1 u_i(g_i) \tag{3}$$

where u_i , $i = 1, 2, \ldots, n$ are non-decreasing real valued functions, named marginal value or utility functions, which are normalized between 0 and 1, and p_i is the weight of u_i. Under the "weights" p, such a model represents the trade-offs among the criteria.

This method was used in decision aiding for different multi-criteria problems and in the environmental field for the evaluation of projects Siskos and Assimakopoulos (1989); Beinat (1997); Valiakos and Siskos (2015); Demesouka et al. (2013). Here we propose to use this family of methods method in order to analyse people values and preferences in a way that represents people behaviour.

We use an implementation of the UTA method, the UTA+ algorithm Kostkowski and Slowinski (1996). The UTA+ method gives a score to each alternative starting from a weak order among a subset of alternatives. This method, based on a principle of ordinal regression, consents to solve the linear problem proposing a set of marginal utility functions compatible with the preferences of the decision maker. The particularity of UTA+ software is that it consents to modify interactively the utility functions (paying attention to the sensitivity analysis) in order to meet the preferences of the decision maker. Finally, a post-optimal analysis (using the Kendall coefficient τ) is made in order to measure the correlation between the ranking defined by the user and the ranking obtained using the utility function found by ordinal regression.

According to this method, we represent the preference relations S using additive value functions. Let u^t denote the value function of tourist t. We define S_t from u^t as follows:

$$(x_1, x_2) \in S_t \text{ iff } u^t(x_1) \geq u^t(x_2). \tag{4}$$

Our objective is thus to obtain the utility u^t from the path data of each tourist x^t. We assume that u^t can be represented as a weighted sum of marginal value functions:

$$u^t(x) = \sum_{c \in C} u_c(x_c) w_c^t, \tag{5}$$

where $w^t \in [0, 1]$ represents the trade-offs among criteria that the tourist t is supposed to give over categories C.

Moreover, given a category of attraction $c \in C$, we define a marginal value function $u_c : \mathbb{R}^+ \to [0, 1]$. We assume for now that such marginal value functions $\{u_c\}$ and the trade-offs may depend on people values and are different for each tourist t, such that the function $u_c(x_c)$ represents the value we assume the tourist gives to spending i_t seconds in the category of attraction c (for example: environmental local attractions), not taking into account the partial weight w_c^t. Finally, we define each partial utility function u_c as a two linear piecewise increasing function.

At the beginning we just know the behaviour of each tourists t and his\her declared preferences. In order to learn the set of tourists' preferences as actually performed we consider the relation among the path chosen by the tourist and a set of "typical paths". We define a typical path as a path that a tourist can freely choose with respect to his personal characteristics and spatial and personal resources and assets (in a capability theory framework (Sen 1999)). A typical path is a combination of categories of attractions C and time τ the tourist ideally spend in (with a maximum of 15 hours of visit per day).

We define the typical paths with an expert of the territory (an urban planner working in the city of Alghero). The set of typical paths consider the trends in the visits (Blečić et al. 2016) and include not expensive and reachable on foot attractions, accessible by all the tourists (see Table 4). We consider the set of typical paths as a set of "tourists' relevant urban capabilities". These are ten typical paths $x_{O_1}, \ldots, x_{O_{10}}$ that we assume tourists have considered because are standard paths available for all people and that allows to develop a set of touristic relevant urban capability. With respect to this, we assume that the tourist t prefers the path x^t he\she has chosen to each of the typical paths $u^t(x^t) \geq u^t(x_{O_i}), 1 \leq i \leq 10$, such that the weak order considered is x^t P Tp^1 I Tp^2 I Tp^3 I Tp^4 I Tp^5 I Tp^6 I Tp^7 I Tp^8 I Tp^9 I Tp^{10}.

Tp	EL	ET	HT	HL	FS	LS	CL	OT
Tp1	6	0	0	0	3	1	1	4
Tp2	0	7	0	0	3	0	0	5
Tp3	0	0	0	2	2	6	2	3
Tp4	0	0	0	4	1	3	0	7
Tp5	0	0	7	3	3	0	0	2
Tp6	6	4	0	1	3	0	1	0
Tp7	7	6	0	0	1	1	0	0
Tp8	2	0	0	6	2	3	2	0
Tp9	2	0	6	0	1	3	2	1
Tp10	1	0	6	0	3	2	2	1

Table 4. Soft set. Number of hours for category of places in the Typical Paths (Tp).

Finally, we define the value function for each tourist with the UTA+ software giving attention to the Kendall's coefficient(for the postoptimization analysis) and considering Ideal and Anti-ideal alternatives in order to establish the maximum and the minimum level of utility.

Selection of relevant factors for personalization

This phase aims to select the relevant socioeconomic factors that influence the choice of a particular path by the tourists. In fact, different people in the same place can choose different paths with respect to personal and contextual factors (in a Capability Theory framework (Sen 1999), see Figure 1 for the conversion process). Here we want to focus on personal factors (gender, age, profession, ...) that influence the choice of people, such is the ability component of the capability. In order to inspect the relation between the path chosen by the tourist x_t and these factors we propose a two phase analysis. In the first step we did a cluster analysis of the preferences stand alone, then we did a rough set analysis among the class of the cluster and the personal information of tourists in order to find the relevant set of features.

Cluster analysis of the utility function. In this phase we classify the tourists using the value functions as revealed by the UTA+ software. Especially, we did a cluster analysis of the value functions (central and maximal point) for the different categories of spaces.

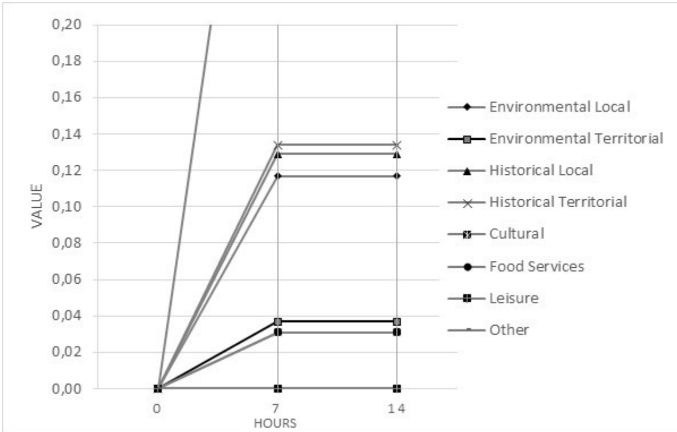

Figure 4. Example of the set of partial value function of the tourist t_1 for the different Categories of Attractions

We did some tests in order to define the better number of cluster for different type of cluster analysis. The tests include the relative cluster validation and an internal validation of cluster. Cluster validation aims to evaluate the clustering structure by varying different parameter values for the same algorithm. Whereas, cluster internal validation analyses the internal information of the clustering process in order to understand the goodness of the cluster with respect to internal data. For this step we use the silhouette analysis that measures how well an observation is clustered and estimates the average distance between clusters. The silhouette plot displays a measure of how close each point in one cluster is to points in the neighboring clusters.

For the cluster internal validation we compute the Model Based Approach with Bayesian Information Criterion (BIC), the average silhouette method and the Dindex, all suggesting models with 3 components (for more details see the appendix). Finally we run the R. (cran Project) Nbclust function that computes a high number of indices for cluster validation. According to the majority rule, the best number of clusters suggested by Nclust is 3, with 7 indices suggesting that model.

All the validation methods suggest a model with 3 component. Among them, we choose to use the classification suggested by the Nbclust method.

Rough set features selection. This phase aims to find a subset of features which have the same quality as the complete feature set. In other words, the purpose of the rough set feature selection method is to select the significant features and eliminate the not relevant ones. We use this method in order to find the socioeconomic features that are useful for the classification of tourists with respect to the cluster families (previous step).

Starting from the knowledge of Y we select the set of attributes $\in A$

$$A = \{hotel, gender, age, country, level\_of\_study, profession, travelling\_with\} \tag{6}$$

The final rough set analysis eliminated the $level\ of\ study$ feature from A, creating a feature subset of 6 attributes Y:

$$A^1 = \{hotel, gender, age, country, profession, travelling\_with\} \tag{7}$$

Cluster Analysis.

This phase is aimed to build homogeneous groups of people with similar values in space. More precisely, we performed a cluster analysis of the max and medium values of utilities functions together with the socioeconomic A^1 data in order to find homogeneous groups of people that value space similarly. That is, groups of people that give the same importance to time spending in particular location of the Alghero's territory.

Having to deal with numerical (utilities/values) and categorical data (socioeconomic information), we cannot use the usual metric distance matrix in order to build the clusters. The Gower dissimilarity index (Gower 1971) is suggested in such cases in order to define distances and centroid for the clusters. The Gower distance calculates for each variable a distance metric fitting that type of variable, then the distance is scaled between 0 and 1. If the variables are quantitative the coefficient used is the range-normalized Manhattan distance converted into similarity. When the variables are nominal the Dice matching coefficient is used that recodes variables into dummy ones. Finally, the final distance matrix is calculated using a linear combination with user-specified weights (an average).

We made different cluster tests and calculate clusters with both the PAM (Partitioned Around Medoid method) and the HC (Hierarchical agglomerative Cluster) method. Finally we choose the HC method which consents to calculate clusters without knowing a-priori the number of clusters. To calculate clusters the HC begins by inserting any alternatives in its cluster and then pairs the two closest ones by examining the distances. There are different methods to examinate distances, among which we choose to use one of the more appropriates for the unsupervised classification: the Ward classification (Ward 1963) that minimizes the total within-cluster variance. Among the cluster agglomeration methods Ward is preferred as it merges at each step the pair of clusters with minimum between-cluster distance.

The results of the classification shows a dendrogram with 5 distinct cluster as suggested by the maximum point of silhouette width visible in (Figure 5).

The resulting clusters show different compositions of individuals and of value functions that we synthesize in Figure 6, 7 and 8. More in details, Figure 6 represents the different personal characteristics that compose the clusters, revealing people with different ages and provenance having similar interests and Figure 7 illustrates the trade offs of values for each cluster. For example, the Cluster2 is composed by European individuals between 30-39 and 50-59 years travelling in couple that prefer to visit Historical (both local and territorial) opportunities and to enjoy of the food services, but taking time to relax in the hotel. The Cluster3 is mainly composed by 40-49 years old individuals coming from Europe, that are public employees travelling with group of friends and that are interested in food services and leisure activities. They are also interested in visit Historical local opportunities, but for just few hours. For a long visit they prefer visit environmental attractions and in historical territorial opportunities. Moreover, we can observe that the Cluster5 is composed by a 70% of people travelling alone of non-European nation, meanwhile Cluster 4 is composed by more than 60 years old retired people, coming from European nations, that travel in family or group and are interested in environmental local opportunities. Finally, Figure 8 illustrates the values of the same urban opportunity for different groups of tourists. For example,

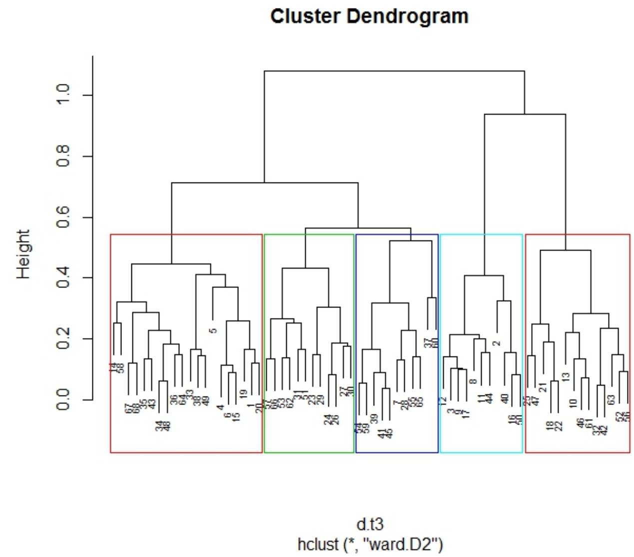

Figure 5. Dendrogram

Historical local attractions have a range of values from 0 for the Cluster4 to 0.13 for the Cluster2, the food services value range from 0.03 for the Cluster2 to 0.22 for the Cluster3, the interest to relax in the hotel range from 0.20 for the Cluster3 to 0.8 for the Cluster4 (composed by more than 60 years old people).

Such data give useful information for the design of legitimated public policies oriented to a touristic deseasonalization. Policies that improve the set of opportunities that are valued as important by the different groups of tourist, and favor the development of a larger set of urban capabilities for such population.

Conclusions and future work.

In this work we propose a replicable method for policy analytics aimed to inspect tourists' values of space (values that individuals give to different territorial opportunities in space) within a capability theory framework using multi-attribute value theory. The problem consists in assessing individual preferences about space, in order to allow designing legitimated public policies. We claim that multi-attribute value theory can offer useful methods in order to unveil the values of what people do and what they believe in space (i.e. developing a set of capabilities). Values of space are useful in order to unveil the desirability of future public policies for different categories of inhabitants. This is due to the overturning from the evaluation of alternatives (endowments and conditions offered by the context) to the evaluation of the value of the opportunities given by such alternatives. These values allows to evaluate the urban capabilities people are interested to choose and develop.

The proposed method generates results that are useful for the policy maker in order to evaluate existing policies as well as designing new ones, since it elaborates a partial order of the values (i.e the objectives)

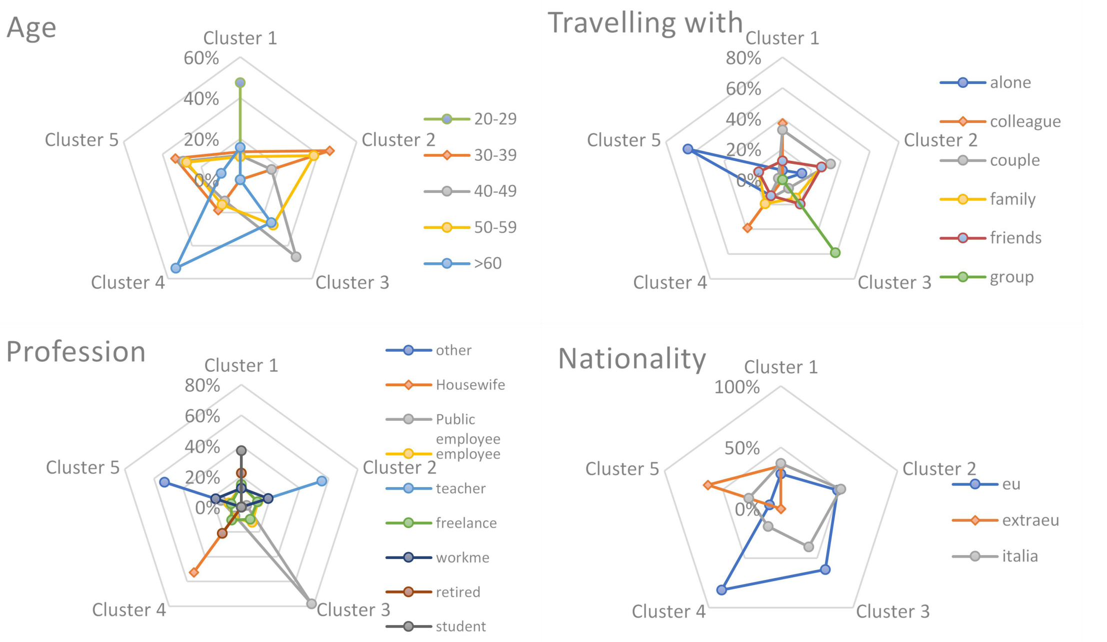

Figure 6. Personal Characteristics

that the project alternatives need to meet. Moreover, it allows to take into consideration the different preferences of the stakeholders in a possibly participatory process, since it allows to classify people in groups with similar values and to design personalized policies.

Another future development of the research concerns the procedure allowing to understand how values are distributed in the territory in order to build maps helping in decision making. In Figure 9 we propose a spatialization of the value of urban attractions (i.e. urban opportunities) for the different clusters. We use the existent paths in order to understand the different distribution of values in space (the intensity of color in the map indicates an intensity of preference for that urban opportunity type). In Figure 9 we can observe how the different groups of tourist's value the possibility to use the space with respect to the opportunity offered by the different categories of attractions (in a low touristic season period). This representation can be seen as the set of possible paths K that can be offered to the tourists that belongs in the same cluster. This means that a tourist that spent his day in the path $x_t \in K$ is also interested in spending time in other paths internal to the K set. Such information is fundamental if we want to improve the set of urban capabilities of tourists with respect to their values, designing legitimated public policies. Improving the set of urban capabilities of tourists in a low season period means designing a strategic policy oriented to touristic deseasonalization and fostering a sustainable development of the territory.

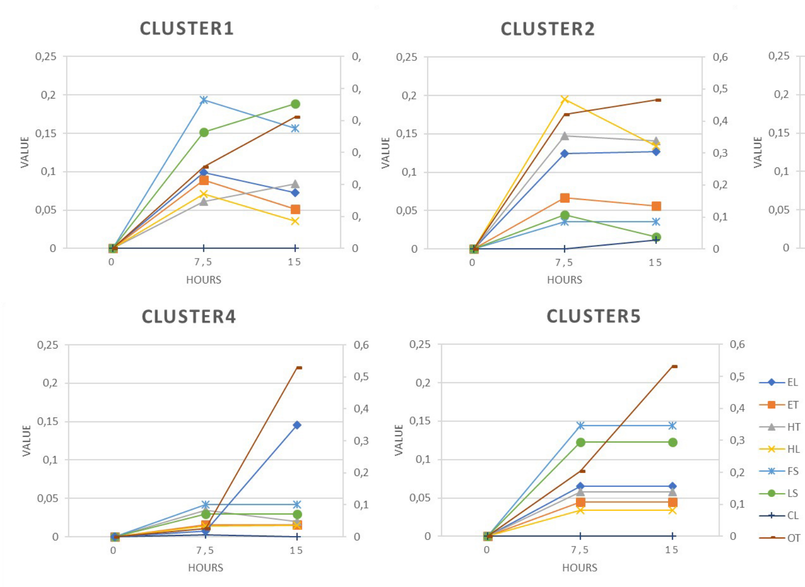

Figure 7. Utility Functions

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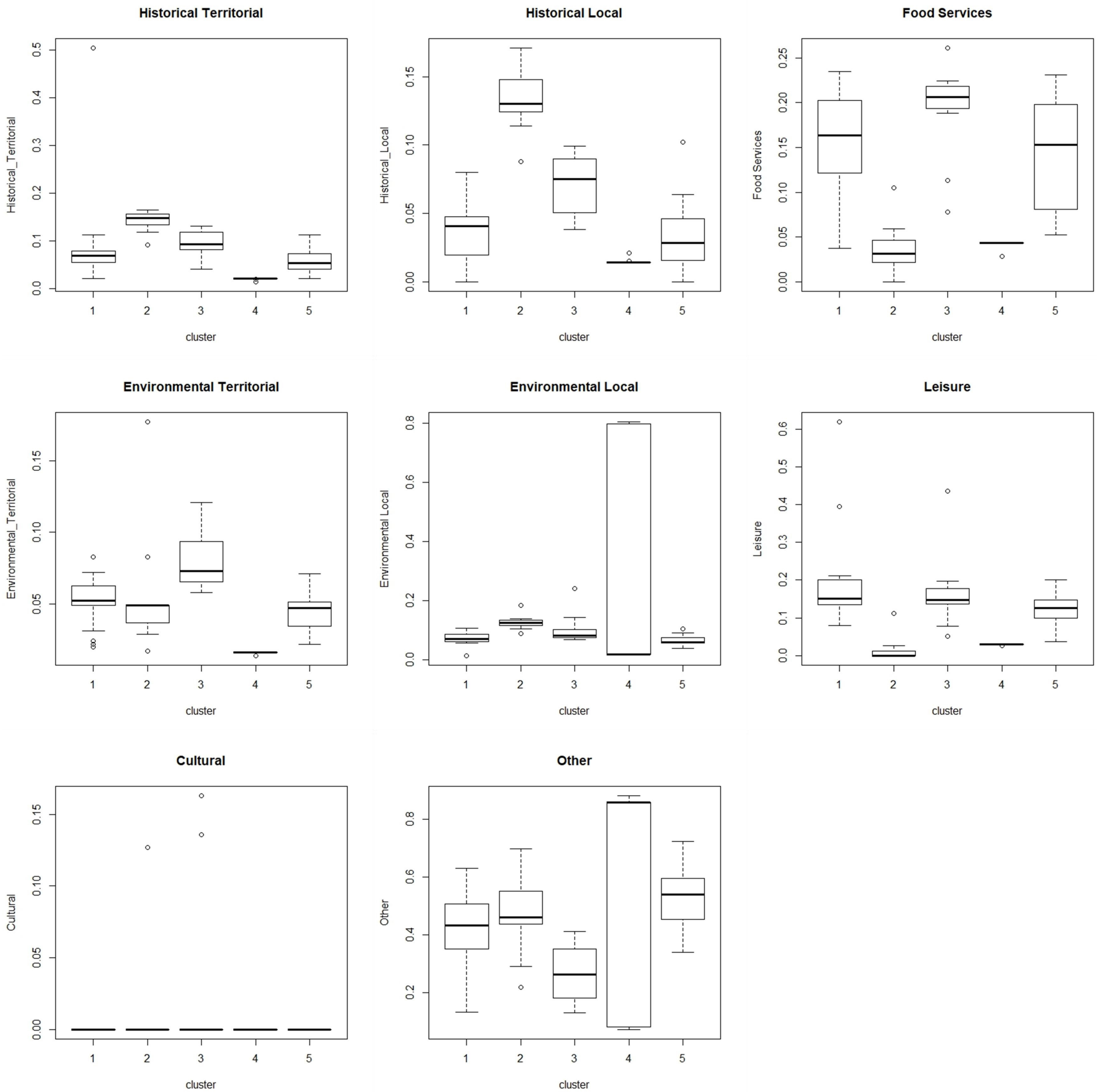

Figure 8. Boxplot of opportunities values for the different groups of tourists

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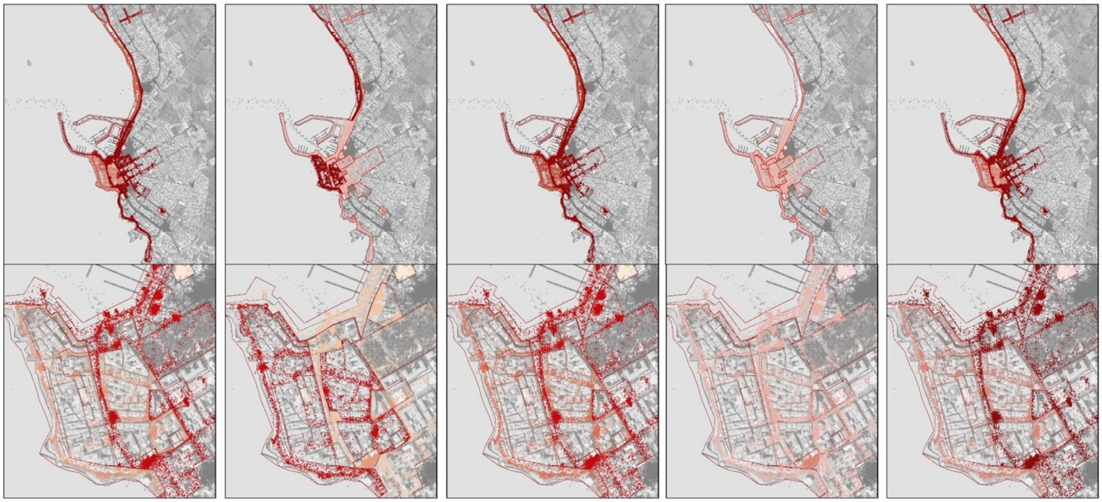

Figure 9. Spatial decision map: summary of clusters. (In order, 1-2-3-4-5 cluster)

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Appendix

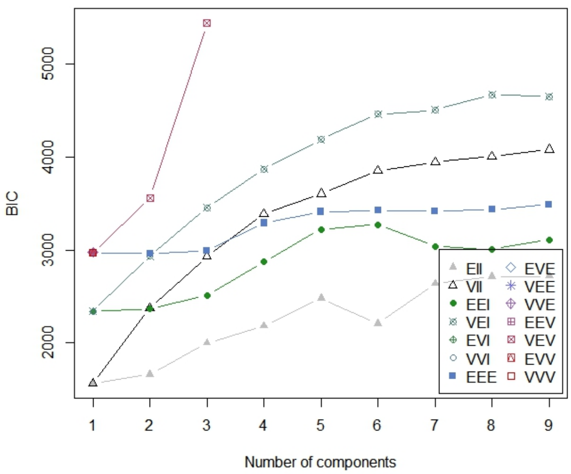

Figure 10. The Bayesian Information Criterion. A large BIC score indicates strong evidence for the corresponding model.

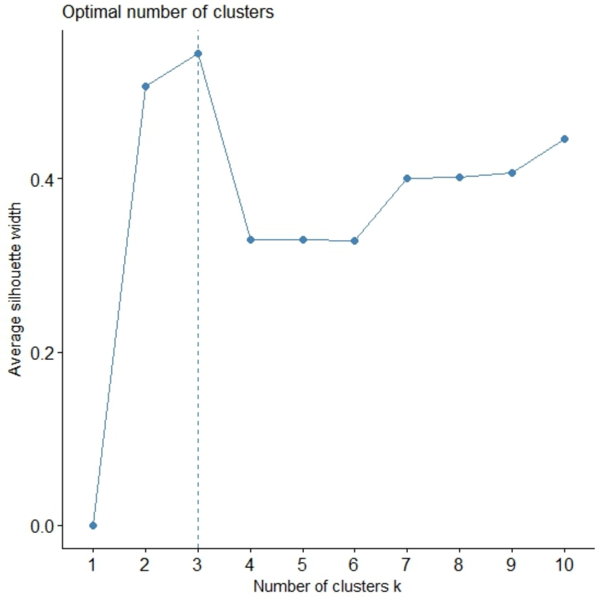

Figure 11. Average Silhouette for Hierarchical clustering

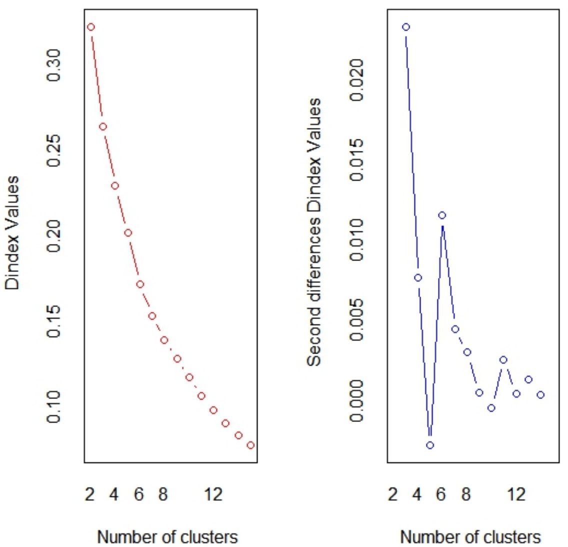

Figure 12. The Dindex

Figure 13. Spatial decision map: Cluster1

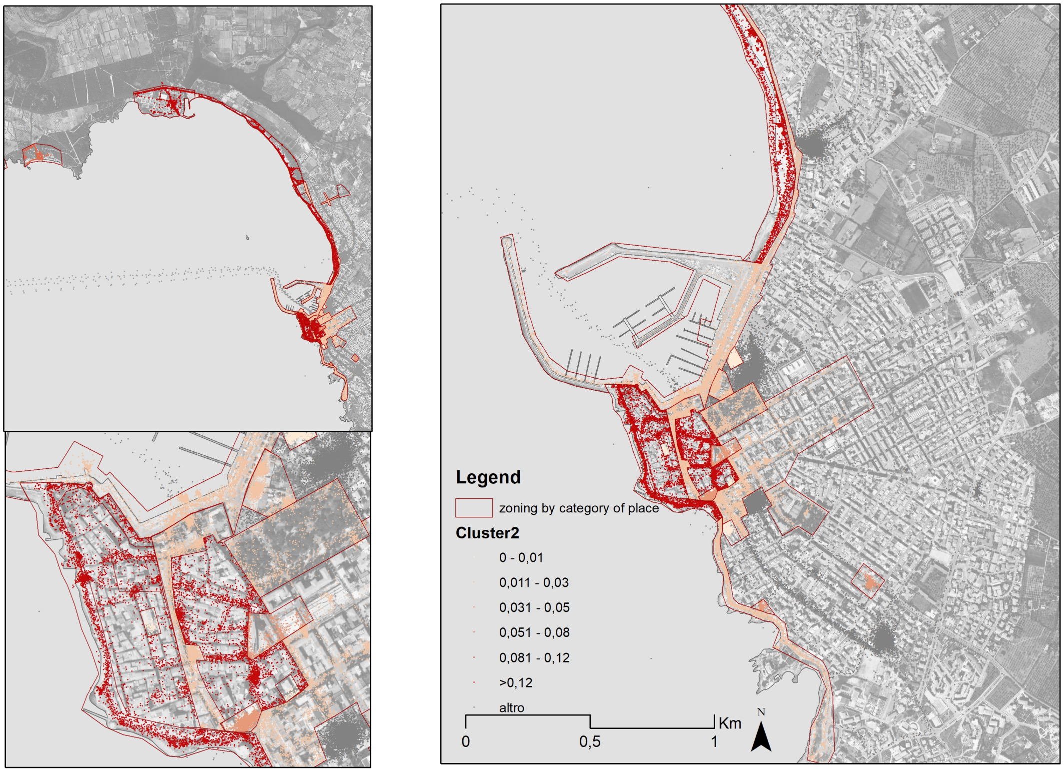

Figure 14. Spatial decision map: Cluster2

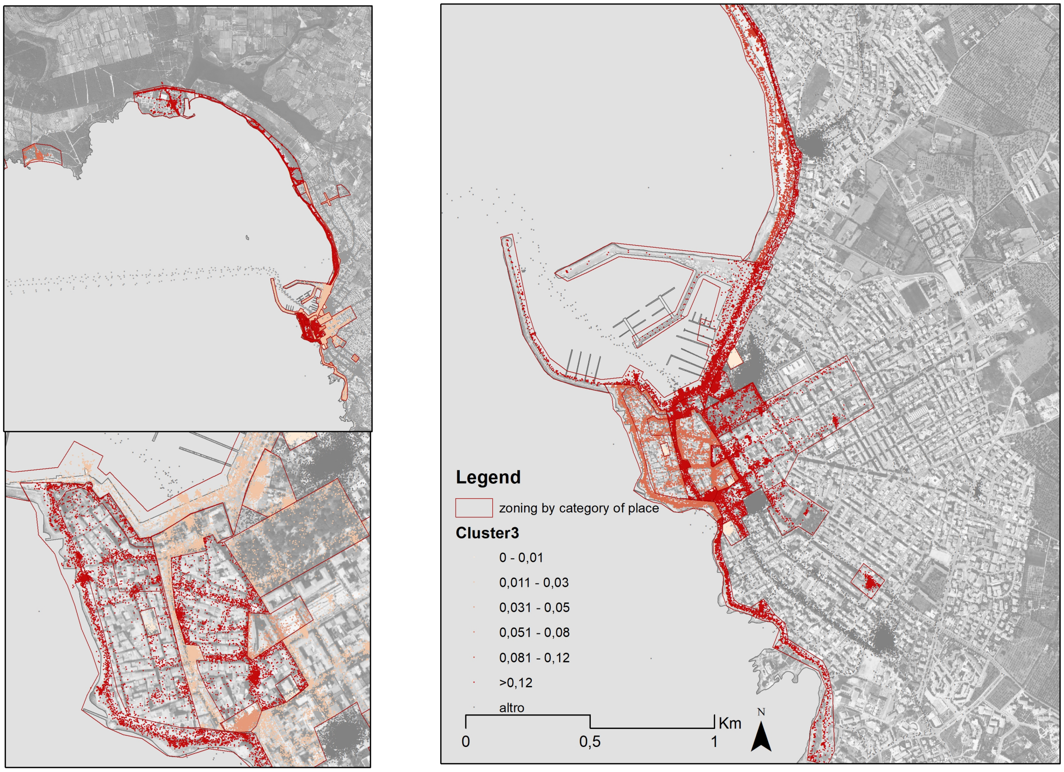

Figure 15. USpatial decision map: Cluster3

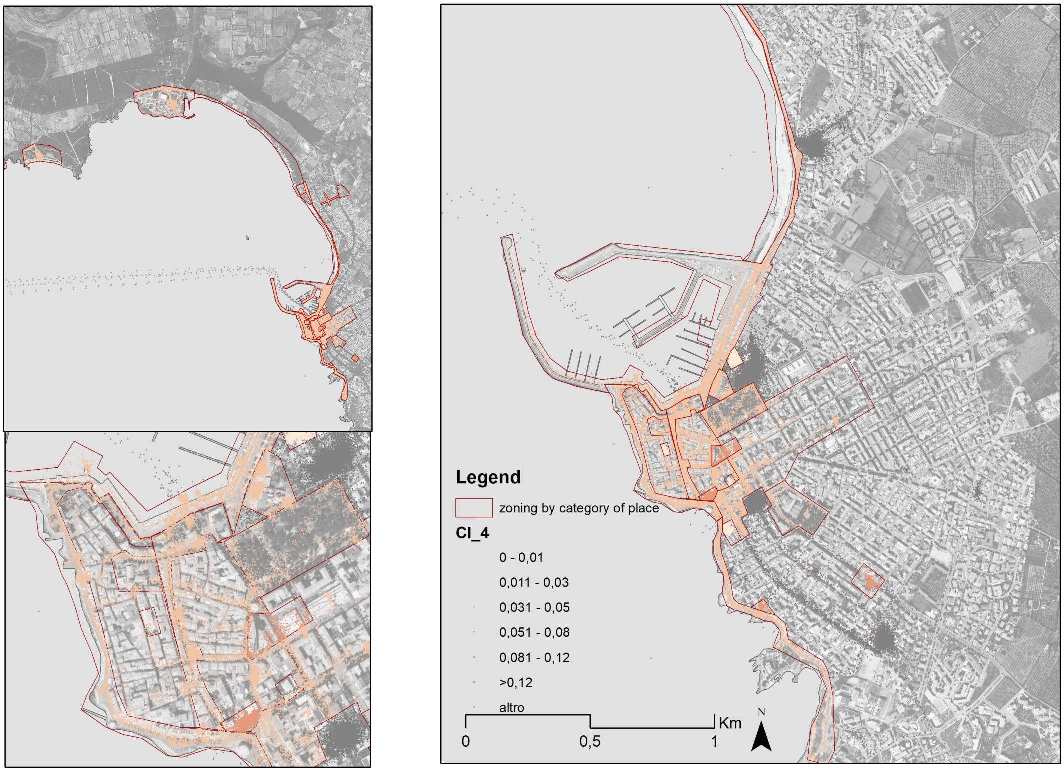

Figure 16. Spatial decision map: Cluster4

Figure 17. Spatial decision map: Cluster5