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OPPORTUNITIES FOR AN EFFECTIVE USE OF SOCIAL MEDIA GEOGRAPHIC INFORMATION (SMGI) WITHIN GEODESIGN APPROACH

Oportunidades para o Uso Efetivo de Informação Geográfica por Mídia Social (SMGI) na abordagem do Geodesign

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ABSTRACT

This contribution focuses on two types of georeferenced User-Generated Content (geo-UGC): Volunteered Geographic Information (VGI) and Social Media Geographic Information (SMGI): both can be profitably used in spatial planning practices, thanks to the high potential of the information they enclose. Several case studies, developed by the authors, are presented to illustrate how geo-UGC can be used in different stages of spatial planning processes, supporting a more multifaceted understanding of places, contributing to more participatory processes, and fostering the collaboration between decision-makers in spatial planning practices. The Geodesign approach has been used as a base framework to underpin the discussion. In addition, the case studies show how geo-UGC can be advantageous in knowledge building on the current regional and urban dynamics, in identifying possible alternatives and in finding agreement on preferred future developments.

Keywords: Social Media Geographic Information, User-Generated Content, Volunteered Geographic Information, Geodesign

RESUMO

O artigo foca em dois tipos de contextos de dados georreferenciados gerados pelos usuários (geo-UGC – User-Generated Content): Informação Geográfica Voluntariada (VGI) e Informação Geográfica por Midia Social (SMGI), que podem ser usadas de modo vantajoso em práticas de planejamento espacial, em função de seus altos potenciais de informações ali inseridas. Alguns casos de estudo, desenvolvidos pelos autores, são apresentados para ilustrarem como o geo-UGC podem ser usados em diferentes etapas do processo de planejamento, dando apoio a uma compreensão mais multifacetada sobre os lugares, contribuindo em processos participativos, e fomentando a colaboração entre tomadores de decisão nas práticas de planejamento espacial. A abordagem do Geodesign é usada como um arcabouço para sustentar as discussões. Os estudos de casos também têm a função de ilustrar como os geo-UGC podem ser vantajosos na construção de conhecimento sobre as dinâmicas regionais e urbanas atuais, identificando alternativas possíveis e proporcionando acordos sobre preferências relativas ao desenvolvimento futuro.

Palavras chaves: Informação Geográfica por Midia Social, Dados Gerados por Usuários, Informação Geográfica Voluntariada, Geodesign.

1. INTRODUCTION

Spatial planning is an interdisciplinary practice mainly focused on the design and management of natural and urban environments, with the aim of increasing the well-being of local communities (Frias-Martinez et al., 2012) and the correct functions of the territorial ecosystems. It is a regional or local authority competence, traditionally, and involves several actors and institutions in the process. Specifying urban land use and identifying landmarks represent two of the most important processes in urban planning, which require planners the provision of accurate information on the urban environment, to develop sustainable decision-making processes and public policies. Usually, this type of information is retrieved thanks to direct observations methods, or using residents or visitors' preference surveys such as field or online surveys (Jankowski et al., 2010). Nevertheless, these methods may be expensive and time consuming.

Other methods, based on the use of remote sensing techniques to analyze satellite imagery and Geographic Information Systems (GIS), can provide useful information concerning land uses (Harris and Ventura, 1995), although, such techniques are not fully adequate to supply updated or real-time information about urban environment. More recently, thanks to the widespread diffusion of Information and Communication Technologies (ICTs), a stronger emphasis has been given to the local communities' involvement in urban planning procedures, fostering the general democratization of the processes in contemporary societies of many western countries (Arnstein, 1969; McTague and Jakubowski, 2013), as well as, improving the communication between authorities and citizens. Emerging technologies have disclosed new and innovative ways of realizing the active involvement of a wider public in spatial planning (Bizjak, 2012), providing more accurate and up-to-date databases on the current environmental situation.

As a dynamic and complex socio-technical process, spatial planning requires multifaceted paradigms, originating in a variety of workflows, practically. In the light of these considerations, this work aims to explore the opportunities for exploiting georeferenced User-Generated Content (geo-UGC) in spatial planning, using the concept of Geodesign (Steinitz, 2012), which is one of many possible ways of approaching spatial planning. Two main categories of geo-UGC of particular interest in spatial planning, either as an information resource or as a communication platform, or both, are identified by the authors: Volunteered Geographic Information (VGI), which is geo-UGC collected by a group of users for a given purpose (e.g. OpenStreetMap.com), and Social Media Geographic Information (SMGI), which is geo-UGC collected by active (e.g. Fixmystreet.org; projectnoah.org, carticipe.net) or passive (e.g. Twitter.com; Instagram.com) social networking platforms.

Geodesign process requires the selection of main variables to represent the area and its demands, and due to that the discussion about data, more specifically about representation models to structure an overview of place, is an opportunity for effective use of geo-UGC. To illustrate the discussion, a set of case studies demonstrates how geo-UGC can be used in planning regarding different stages of the Geodesign process. The paper concludes drawing conclusions from the obtained results, and remarking the growing importance that SMGI may assume to support spatial planning analyses and practices, thanks to the integration of official and experiential knowledge in Geodesign.

2. THE NOVEL SOURCES OF GEOGRAPHIC INFORMATION AND THE SMGI FRAMEWORK

In recent years, major opportunities for innovation of spatial planning practices are emerging from the avalanche of digital Geographic information (GI), which Communication Technologies (ICTs) and Web 2.0 are increasingly supplying through the Internet to the wider public. This phenomenon may foster advances in spatial planning, given that most of the information necessary to elicit useful knowledge for analysis is georeferenced or inherently spatial in nature.

Since the late 1990s, advances in Spatial Data Infrastructures (SDIs) enabled the access to digital data, produced and maintained by public or private organizations for institutional or business purposes. Currently in Europe, the implementation of the Directive 2007/02/CE (INSPIRE) is leading to the development of SDIs in Member States and regions, allowing the public access and reuse of official information, or Authoritative Geographic Information (A-GI), thanks to common data, technology, and policy standards.

More recently, advances in mobile connectivity and Web 2.0 are facilitating the access, production and sharing of georeferenced User-Generated Contents (UGCs) (Krumm et al., 2008) among millions of users worldwide, while strengthening the online community's role in data production and sharing. This novel type of GI is referred to as Volunteered Geographic Information (VGI), stressing the voluntary effort of users for collecting and contributing to this spatial data (Goodchild, 2007). Furthermore, Social network sites (SNSs) are gaining huge popularity among online public, easing the diffusion of georeferenced multimedia through the Internet (Sui and Goodchild, 2011). Commonly, social networks employ mobile and web-based technologies to supply highly interactive platforms to the public, via which users and communities may share, create, discuss, and modify UGCs, potentially commenting or rating in different ways any piece of information.

This information, namely Social Media Geographic Information (SMGI) (Campagna, 2014), may be considered a deviation from the VGI nature, since the voluntary GI collection and dissemination are not the pursued intents of users. Nevertheless, the growing appeal of social networks, and particularly of location-based social networks, to a wide audience is driving geography into daily routines of people, leading the forecasted convergence of GIS and social media, as argued by Sui and Goodchild (2011), and enabling the sharing of knowledge not only about facts on the Earth surface but also about environmental, social and cultural phenomena. Indeed, the creation and dissemination of VGI and SMGI by users is transforming the Internet in an affordable and potentially boundless source of information about everyday life, events and opinions and needs (Gräbner et al., 2012) of users in space and time (Campagna, 2014).

Despite that, social networks offer different ways for managing, sharing and extracting contents, thus determining a degree of uncertainty for the knowledge processing, SMGI provides opportunities for real-time monitoring of local communities' trends, possibly affecting the way current practices in urban and regional planning are developed. The major hurdles limiting a wider use of SMGI in practice may be found both in the shortage of user-friendly tools to collect and to manage huge data volumes and, particularly, in the data structure of this information, which on the one hand discloses a plethora of novel analytical opportunities, but on the other hand it is difficult being analyzed by traditional methods. Indeed, SMGI, as a UGC with an associated geospatial component, combines the spatial and the temporal dimension of geographic information with a third dimension, namely the user itself, thus extending the range of available analytical methods with new analytical capabilities, such as user behavioral analysis, user interests investigation, land segmentation, and potentially any analysis based on the combination of space, time and user (Campagna, 2014). It is important to understand the specific characteristics of SMGI, and the differences between the authoritative information (A-GI) and the SMGI data models (Fig. 1).

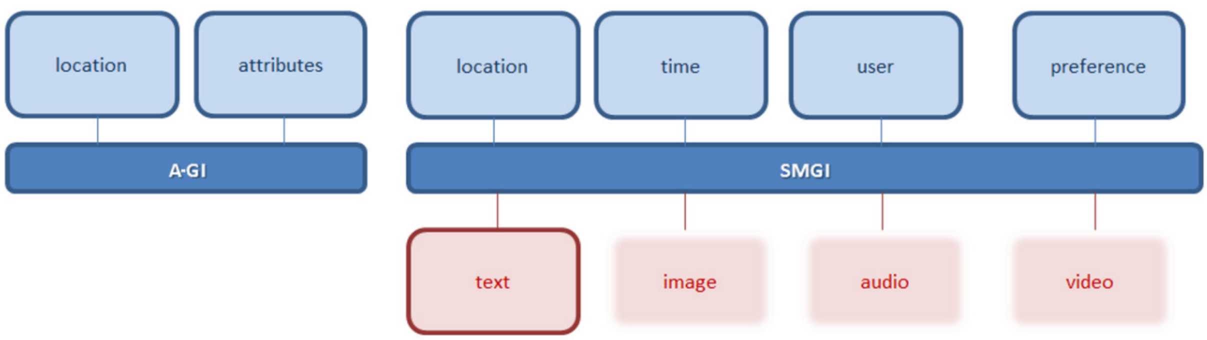

Fig. 1. A-GI and SMGI data model.

The range of analytical methods to deal with SMGI, as explained in the remainder, may represent an opportunity to investigate facets of the social and cultural habits of local communities, but their implementation may represent a challenge, which requires the integration of traditional spatial analysis methods with expertise and contributions from various disciplines such as social sciences, linguistic, psychology and computer science (Stefanidis et al., 2013). Issues related to the knowledge extraction have started to be addressed by the application of Spatial Data Mining and Geographic Knowledge Discovery, which are emerging research fields concerned with the development of theory and methodologies to extract useful information and knowledge from complex spatial databases (Andrienko and Andrienko, 1999). The methods provided by these research fields are exploratory in nature and more inductive than traditional ones, embracing clustering, classification and association rules mining techniques, as well as, visual analytics (Miller and Han, 2009).

In the light of these considerations, any framework should include not only common spatial analysis methods, but also novel and tightly integrated methods to deal with temporal, user and multimedia dimensions. In this respect, the authors propose a framework to fully exploit SMGI, namely SMGI Analytics, to enrich the knowledge base about the local context and to support spatial planning practices. The framework consists of several analytic methods that may be used in different scenarios for investigating spatial patterns, temporal trends, as well as users' movements, opinions and preferences. Among several analytical methods, suitable for different planning scenarios, the SMGI framework consists of:

• Spatial analysis of users' interests. SMGI may be used to investigate the patterns of users' interest in space by kernel density and/or clustering and classification functions. The overlay of authoritative information and SMGI may offer hints to public authorities to understand which places attract the major interest of users and how these places are perceived by local community.

• Spatial statistics on users' preferences. SMGI collected by spatial units may enable spatial statistics analysis of users' preference at different geographic scales by means of different techniques, such as the hot-spot analysis.

• Multimedia contents analysis. Multimedia contents may be analyzed to extract further useful insights on user opinions and preferences by means of different techniques, such as novel text analytics that allow inquiring natural language texts.

• Temporal analysis of users' patterns. SMGI may lead analyses for the study of temporal patterns and trends related to specific destinations, neighborhoods, public spaces, or other public services.

• Users' behavioral analysis. SMGI may enable the investigation of users' behaviors in space and time, as well as, fostering the development of techniques to segment local community's contributors in groups per demographic characters and cultural habits, potentially introducing user profiling methods in spatial planning methodologies.

• Combination of several analytical methods which take advantage of different methods to gain further insights on what people discuss, perceive, and how they interact and behave allowing in detail investigation of urban environments and local communities (Campagna et al., 2015).

Several of the analytical methods mentioned are discussed in further details in the case study section, where the obtained results are used to demonstrate the opportunities of SMGI and the capabilities of the framework to deal with official and volunteered information to support Geodesign approaches in urban planning.

3. GEODESIGN AND SMGI FRAMEWORK: NEW OPPORTUNITIES ARISING FROM A-GI/SMGI INTEGRATION

Since recent years, the term Geodesign is emerged among spatial planning and GIS scholars labeling an approach to planning and design deeply rooted in geographic analysis and able to inform collaborative decision making (Steinitz, 2012). Geodesign may be defined as an integrated process informed by environmental sustainability appraisal, which aims to solve complex problems related to territorial and environmental issues, as well as, to social and economic matters (Dangermond, 2010). Operatively, Geodesign works as a design and planning method which interlaces the development of alternative design proposals with a seamless impacts simulation informed by geographic contexts and digital technology (Flaxman, 2010).

As an integrated and multidisciplinary process, Geodesign includes project conceptualization, knowledge building, analysis, alternative design, impact simulation and assessment, decision-making, collaboration and participation, involving political and social actors and relying on scientific geographic knowledge support. The main innovation in Geodesign may be found in the extensive use of digital spatial data, processing, and communication resources - such as ICTs and GIS - which may enable a more effective use of scientific and societal knowledge in planning, design and decision-making (Ervin, 2011). Indeed, as claimed by several scholars and industry experts, the current technology may be considered mature enough to exploit the ICTs support in the planning practices, overcoming the barriers which until now have limited de facto the new technologies' use (Göçmen and Ventura, 2010).

To apply Geodesign in practices, Steinitz (2012) proposed a complete methodological framework, namely "Geodesign Framework", which consists of six models, iteratively implemented in order to design future developments alternatives and to identify potential consequences of these scenarios thanks to territorial context description, dynamics analysis and impacts evaluation. The six different models, defining the core of the Geodesign Framework, are representation, process, evaluation, change, impact and decision. Each model aims to answer questions during its implementation (Fig. 2).

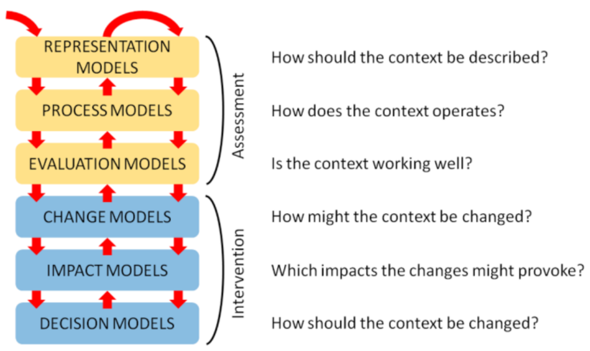

Fig. 2. The Geodesign Framework. Adapted by Steinitz (2012).

The three initial models depict the current situation of the territorial context by describing (1) the environmental system and explaining (2) its evolution, mainly focusing on (3) opportunities and threats that may be devised. Conversely, the three last models define potential alternative scenarios for (4) transformation, (5) assessing potential beneficial or dangerous impacts on environmental and human systems, and eventually (6) supporting stakeholders during the decision-making process. A complete Geodesign study is implemented through three iterations along the six models, following first a "data driven" approach, then a "decision driven" flow, and finally a "data concerned" process. The linearity along the iterations is not strict and several feedbacks or shortcuts might be required before a proper study completion.

To achieve the participation and collaboration among stakeholders, technicians and public in dealing with complex problem-solving, one of the main innovations of Geodesign is the major role dedicated to digital spatial data and processing resources for fostering an efficient use of scientific and societal knowledge in planning processes. In this regard, VGI and SMGI may be integrated with authoritative information to offer knowledge related not only to geographic contexts, but also to users' perceptions and opinions on places, localities and daily-routine events.

During the representation model, both official and unofficial data may be integrated to feed the proper abstraction and description of geographic context. The use of VGI and SMGI contents related to a specific geographic area may enclose experiential information that is usually dismissed in official information, supporting a more pluralist vision of the geographic, social and cultural systems. On the one hand, A-GI may offer official information about quantitative measurements, while on the other hand, VGI and SMGI may help in identifying peculiar social and cultural dynamics affecting the geographic context. Then, A-GI and geo-UGC may be combined and processed during the process models to investigate how spatial phenomena evolve in time. As a matter of fact, VGI and SMGI through API access provide updated and (near) real-time information, which may be used to feed predictive models and analyses – as those described in the following section- aimed at identifying trends and phenomena affecting the area. Moreover, A-GI, VGI and SMGI may disclose notable opportunities to study the current situation of the geographic context during the evaluation model, providing further knowledge concerning the preferences and the social dynamics of users.

The integration of technical and experiential knowledge may represent a way to gain insights about social and cultural dynamics, which may help decision makers to promote a constructive dialogue about the future of places, proposing informed alternatives through the help of local community's experience (March, 1994) during the change model. As a matter of fact, the local knowledge of the residents is commonly considered exclusively as an opinion in planning processes (Fischer, 2000; Rantanen and Kahila, 2009), but the technical knowledge, providing only a part of the required knowledge basis, may be not sufficient to properly guide the decision-making (Lindblom, 1990). Hence, the spatial UGC may be proficiently used to assess the impacts of alternatives, supplying useful knowledge about the potentials and the risks of places (Rantanen and Kahila, 2009) during the conduction of impact model. Finally, despite the difficulties in converting experiential knowledge into explicit information (Nonaka and Takeuchi, 1995), this information may be used to foster a communicative process, wherein the interlacing between expert and experiential knowledge is crucial (Khakee et al, 2000). The integration of A-GI, VGI and SMGI may support this process, providing knowledge about geographic and social context (Coburn, 2003), which may affect the decision-making processes during the decision model. This way, both technical knowledge and experiential knowledge may be used to build a shared and sustainable development process for the territory among the different involved actors.

Therefore, a Geodesign approach may take advantage of VGI and SMGI thanks to advanced technological instruments and methods, which should be able to collect, process and analyze this novel kind of information during the framework iterations, to achieve a more transparent, democratic and pluralistic planning process. This way, as shown in the remainder, the study might delineate alternative scenarios for the geographic area based upon not only technical knowledge, but also societal and cultural knowledge, deeply rooted in the geographic context, potentially achieving a plan that satisfies the real expectations of people.

4. CASE STUDIES

In the light of the above premises, a few case studies are presented in this section. Each study aims to demonstrate the opportunities arising from SMGI for supporting one or more specific models of the Geodesign framework. Moreover, all these examples are settled in different geographic areas at different scales, taking advantage of information retrieved from diverse social networks.

4.1. SMGI in representation model: investigating the geography of places

Nowadays, Instagram is one of the most popular online social networks worldwide, and it enables users to take, upload, edit and share photos with other members of the service through the platform itself, or by connecting with other social media platforms. In fact, approximately, 20 percent of the Internet users aged 16 to 64 have an account on the service, and the trend is growing over last years. Among the features offered until 2016 by Instagram, the platform allowed users to share, in addition to a multimedia content, also a geotag, namely the latitude and the longitude of the place wherein the content is taken, thus enabling to share through the Internet a georeferenced UGC. Big share of the posts were geotagged indeed. This capability plays a central role in considering Instagram contents as SMGI and may foster the development of specific analyses to investigate spatial and temporal patterns within any geographic area where the service is available.

The case study developed by the authors and discussed in this section concerns the Iglesias municipality (Italy) and it takes advantage of Instagram SMGI to explore the geography of the place through spatial and temporal patterns of the contributions, investigating trends and the main areas of interest within the municipality based on shared contributions by online users. This novel source of information may be useful to depict the current situation of the place and it may represent a valid addition to the availability of official information used during the conduction of the Geodesign representation model. The application of SMGI Analytics on the case study of Iglesias municipality was developed according the stages: (1) data collection, (2) spatial and temporal analysis, and (3) cluster analyses on the SMGI dataset.

The data collection is carried out by setting the spatial limits on the municipality of Iglesias boundaries, meanwhile the temporal dimension embraces a one-year period (from 1 August 2013 to 1 August 2014). The extraction results in the collection of a one-year sample of approximately 14.000 geotagged photos from over 1.200 users in the study area. Each collected photo or video is georeferenced per latitude and longitude, embedded in the spatial metadata of the content, namely the geotag. In addition to the geotag, the dataset consists of several attributes, such as name of the place, if set by the user during upload, user name, user id, user picture URL, media URL, date of creation, number of comments, number of likes, tags and captions. These attributes are made available for any Instagram content if the user's profile is set to public, and may offer notable opportunities to develop multidimensional analyses if properly combined with other official or unofficial spatial layers. However, even though these pieces of information are publicly made available, user data are anonymized to avoid any potential privacy issues before the storage and processing stage.

Following the data collection, the spatial and temporal components of the SMGI dataset are investigated directly in GIS environment to identify potential patterns of interest in the area and eventually to detect local community dynamics. During this stage, the SMGI dataset is integrated with several official datasets made accessible by the regional SDI (Spatial Data Infrastructure) of Sardinia and related to the Iglesias municipality such as settlements, roads network, and buildings using GIS. An exploratory analysis of the dataset spatial distribution shows a high concentration of SMGI within the built environment with approximately the 89% of the contents located in settlements. Similarly, an exploratory analysis is carried out on the temporal component of the SMGI dataset for different time periods to identify trends and/or patterns.

The results show that SMGI is mainly contributed by users during spring (30.9%) and summer (33.3%) in contrast to winter (19.1%) and autumn (16.7%), as confirmed also by the month distribution. The daily temporal distribution shows higher percentage during weekends (Saturday and Sunday), while the daily hours' trend identifies two peaks of interest both for workdays (Monday to Friday) and weekends (Saturday to Sunday). The peaks are in the periods 14:00-15:00 and 21:00-22:00 for workdays, and in the periods 14:00-15:00 and 20:00-21:00 for weekends (Fig. 3). This information might be considered a descriptor of the social and cultural behavior of inhabitants, namely a kind of footprint of the societal habits, as claimed by Silva et al. (2013) in a similar study that compares temporal patterns of users' contributions in different countries.

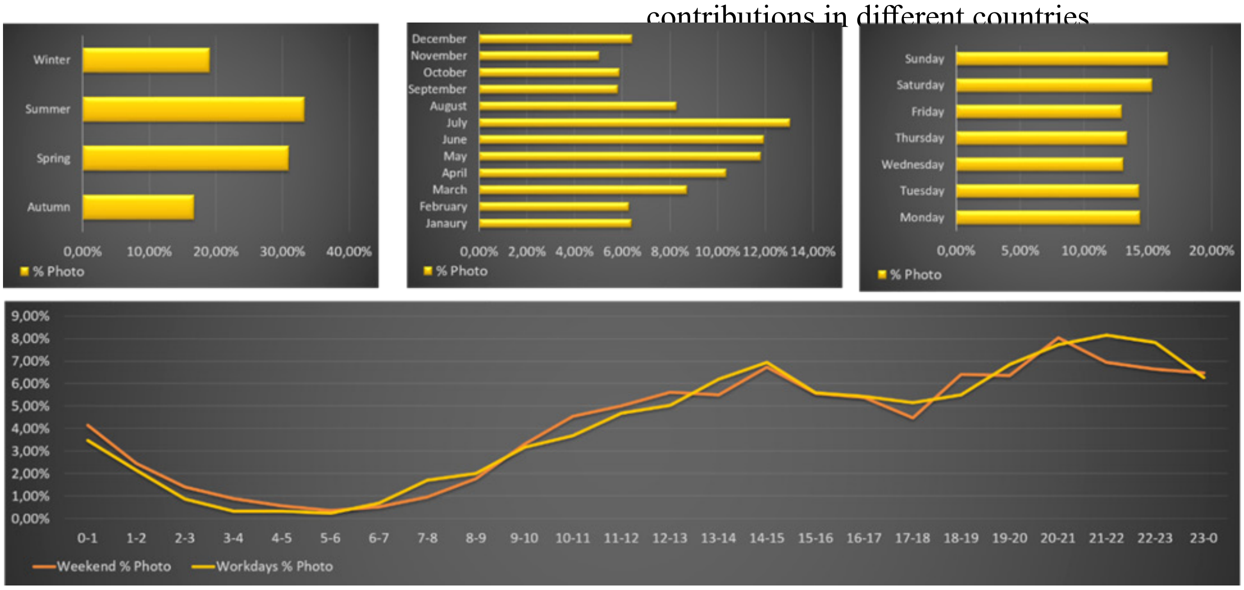

Fig. 3. SMGI temporal distribution. Season, month, day of the week, weekends and workdays trends (from top-left to bottom).

The results obtained from exploratory spatial and temporal analyses anticipate the development of analysis for investigating the geography and the dynamics in the municipality. The higher density of SMGI toward certain specific spaces of the built environment may require the use of advanced analytical methods to explain this interest of the users, particularly. Thus, the Density-Based Spatial Clustering of Applications with Noise (DB-SCAN) algorithm (Ester et al., 1996) and a slightly modified version called Feature-based DB-SCAN (FB-DBSCAN) are used to detect clusters based on density of SMGI in the municipality of Iglesias. DB-SCAN algorithm offers major advantages in respect to other clustering algorithms.

First of all, it is not necessary to know the number of clusters to identify and these clusters may notable differ each other both in size and in shape. Second, only two parameters are required to conduct the analysis, namely ε (eps) and min_pts. The 'eps' is the maximum threshold distance used to establish if a point is included in a specific cluster, while the min_pts value is used to set the minimum number of points required to define a cluster. From an analytical perspective, it is not possible to properly set the value of eps and min_pts prior to the computation, thus the algorithm is iteratively runt on the SMGI dataset until the most suitable solution is found. The preferable value for the study are, obtained from the results, are $\varepsilon = 20$ meters and min_pts = 5. These parameters allow covering with a cluster the shape of a medium-sized fabric, guaranteeing at the same time avoiding false positives in cluster detection. The results of clustering analysis with the above parameters identify 290 clusters within the urban area of Iglesias, and allow the detection of two main clusters wherein most of the users' contributions are concentrated.

In order to explain the two main clusters deserving the major attention of users, a secondary SMGI extraction was carried out by the authors by harvesting data through APIs from the social networks Foursquare and Instagram Places, respectively. The extraction results are assessed to identify the shared Point of Interest (POI) in both the datasets, with the aim of detecting the 5 most visited places. The results demonstrate that these clusters concern the historic center of Iglesias and public space areas. A closer look to the clusters shows that the top cluster includes the historic Cathedral of Santa Chiara (Fig. 4), the main avenue for leisure and night life of the municipality, namely Via Matteotti (Fig. 6), the municipal public garden (Fig. 8), La Marmora Square (Fig. 5) and Sella Square (Fig. 7), these last ones the two of the main squares of Iglesias.

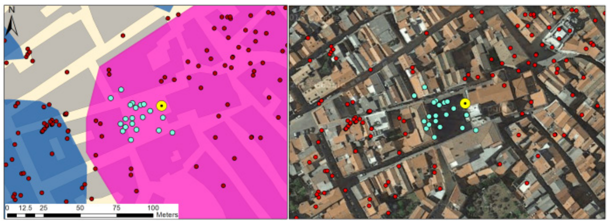

Fig. 4. Identification of the Santa Chiara Cathedral.

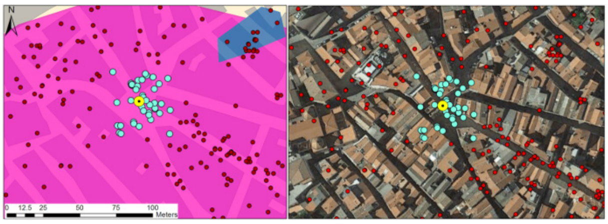

Fig. 5. Identification of the Piazza La Marmora square.

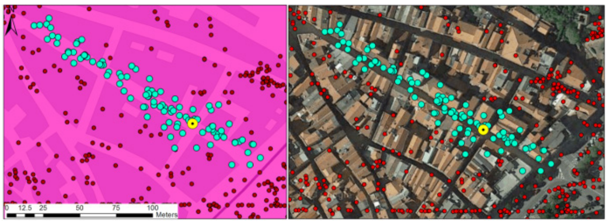

Fig. 6. Identification of the Via Matteotti avenue.

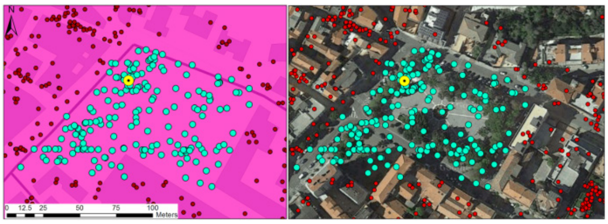

Fig. 7. Identification of the Piazza Sella square.

Fig. 8. Identification of the municipality public garden.

The proposed approach demonstrates how the use of SMGI may be useful to elicit information on places in near real-time, reducing the issues for direct investigations or surveys conducted on the local community. This capability represents a great opportunity to support the first stage of a Geodesign study, namely the *representation model*, enabling to enrich the official data with further information on the context. Obviously, the findings of the approach might be further investigated with empirical methods. However, this kind of exploratory analysis may be useful for informing and guiding further analytical efforts.

4.2. SMGI in Process Model: the identification of spatial clusters

This methodological approach builds on a cluster analysis regarding the extraction of SMGI from *Instagram* and *Foursquare* with the aim of eliciting further knowledge related to specific public spaces in the study area, namely the Poetto beach and the Regional Park of Molentargius in Cagliari municipality, Sardinia. Coupling information from multiple sources may allow the identification of specific *Points of Interest* (POIs) in the study area, easing the evaluation of the reasons behind the importance of the 'proximity to the beach' explanatory variable of the GWR model. The data collection is conducted extracting *Instagram* SMGI related to the public spaces for a period of one year (May 2012-May 2013) and collected in a dataset of 34,776 geotagged photos, contributed by 8,350 users, that comprises metadata about the spatial, temporal and user dimensions (Fig. 9). Following the data collection, the SMGI dataset is investigated by means of a clustering analysis conducted through the DBSCAN algorithm (Ester et al., 1996), which relies exclusively on the spatial distribution of points. The clustering analysis enables the identification of 220 clusters within the study area, comprising more than 22K photos.

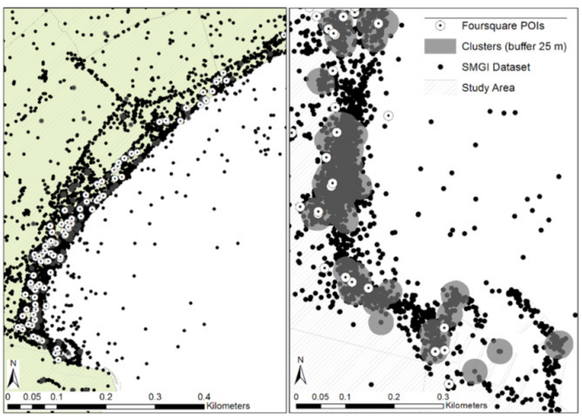

Fig. 9. POIs identification: clusters, Foursquare POIs and Instagram SMGI

The results demonstrate the major interest of *Instagram* users toward the coastal area, where most of the clusters are identified. The first part of the Poetto beach, exposes the highest presence of clusters, probably because the presence of many venues popular among users. To gain further insights about the users' preferences for the identified clusters, a SMGI extraction from *Foursquare* is conducted identifying the most appreciated and visited venues in the clusters, relying on the information provided by the social networks about "number of check-in".

The extraction results in a dataset of 177 POIs (points of interest), which are assigned to clusters and evaluated in terms of typology and specific degree of attractiveness. Only one specific POI is assigned to each cluster relying on its own attractiveness if it is embedded within the cluster area or by means of both its own attractiveness and its spatial proximity if a cluster does not contain any POI. The analysis is conducted firstly considering the POIs typology by exploiting the predefined categories of *Foursquare*, which automatically assigns each location to a category, and allows the identification of the most visited typologies of POIs per users' preferences (Table 1). Afterwards, the POIs are individually examined at the local scale, identifying the specific venues which are mainly frequented by users and their typology (Table 2).

TABLE 1 - MOST VISITED POIS FOR TYPOLOGY PER USERS' PREFERENCES IN THE STUDY AREA.

POIs Typology	POIs number	POIs Typology	POIs number
Beach	38	Café	35
Italian Restaurant	16	Hospital	11
Restaurant	8	Bar	7
Cocktail Bar	7	Pizza Place	7
Snack Place	7	Playground	5
Spa	5	Bed and Breakfast	4
Cafeteria	4	Food court	4
Ice Cream Shop	4	Surf Spot	4
Dog Run	3	Fast Food Restaurant	3

TABLE 2: PREFERRED POIS BY USERS VISITS WITHIN THE STUDY AREA.

POIs Name	n.	Typology	POIs Name	n.	Typology
Calamosca	6	Beach	Il Lido	6	Beach
Sella del Diavolo	6	Cafè	Ospedale Marino	6	Hospital
Cnt Donna Binaghi	5	Hospital	La Pirata	5	Restaurant
Le Terrazze	5	Cocktail Bar	Bobocono Beach	4	Ice Cream
Calafighera	4	Beach	Capolinea	4	Beach
Emerson Cafè	4	Cafè	Kaìros	4	Cafè
La Lanterna Rossa	4	Cafè	La Mari-nella	4	Restaurant
La Roton-dina	4	Cafeteria	Sa Sesta @ Poetto	4	Beach
Spinnaker	4	Food Court	Twist	4	Cafè
Il fico d'in-dia	3	Cafè	La Paillote	3	Cocktail Bar

The obtained results demonstrate the potentialities of SMGI to elicit information related to the geography of places, fostering the POIs identification within the study area, enabling the characterization of the public place. As a matter of fact, the results show that the area is mainly visited for the presence of both natural resources such as beaches' areas and several leisure places, namely café, restaurant and bar.

4.3. The SMGI in Evaluation Model: Spatial statistics of user preferences

This methodological approach builds on a preliminary analysis regarding the tourists' social networks' contents for the Sardinia region, Italy, to identify the most popular destinations, the relationships between the quality of tourist lodging services (TLSs) and their locations, and the spatial distribution of tourists' preferences. We use a combination of A-GI and SMGI to describe location. The analyses are developed aiming at understanding the reasons behind the detected patterns and explaining success factors of destinations' and TLS.

Firstly, the study is carried out through the construction of a database of 1992 records based quantitative information, concerning the TLSs scores and qualitative information related to TLSs information and 1 million of tourists' textual reviews, which are drawn from tourists' ratings extracted from *Booking.com* and *TripAdvisor.com*, and collected for the period May 2012-May 2013. Then, a spatial analysis of users' opinions and attitudes, relying upon spatial statistics and spatial, temporal and textual analysis, has been implemented to identify clusters of TLSs showing high concentration of users' preference at the regional level. Finally, at the local level, analyses are developed to discover through the investigation of textual contents why tourists prefer some destinations rather than others (qualitative analysis); therefore, a quantitative assessment, related to the location of tourists' preferences and to the factors that contribute to this phenomenon, is implemented integrating SMGI and available A-GI. This step is carried out for the destination of Cagliari (Italy), which shows a highly-successful tourist performance.

An exploratory analysis shows how regional TLSs may be classified in five types of accommodation: agritourism (6%), bed and breakfast (15.7%), hotels (42%), tourist houses (29%), residences and resorts (7.3%). The analysis of the significance of tourists' appreciation reveals that 92% of tourists' reviews concerns TLSs located in the coastal areas, while less than 8% are related to the inner areas (Fig. 10).

The application of spatial analytical techniques aims at exploring the spatial patterns of tourists' perceptions and their relationships with other territorial variables. For each TLS, the database includes a score record that is the average of six attributes: geographic position, services' proximity, price/quality ratio, staff quality, room cleanliness and TLS's perceived comfort. Data are normalized by municipality and ranked by the same scale to identify the locations most affected by Tourists' positive preferences incidence (TPPI) in Sardinia. Results demonstrate how the municipalities located along the coastal area attract tourists, while the inner areas are less attractive. Then, integrating SMGI and A-GI and carrying out spatial analysis and statistical techniques, the study investigates the potential reasons behind the tourists' preferences toward certain locations at the regional scale (qualitative analysis).

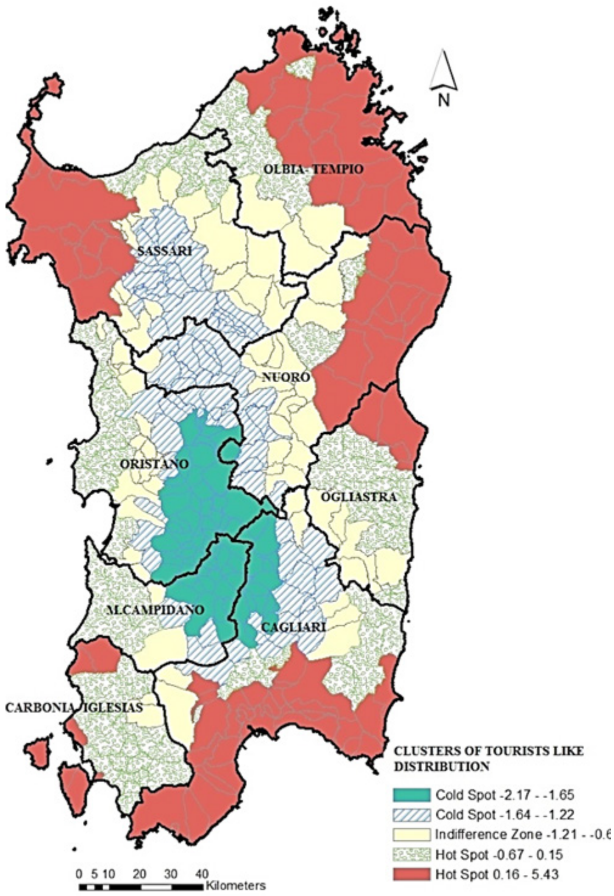

Fig. 10. Spatial Cluster of tourists' preferences by Municipalities in Sardinia

The SMGI-based analysis assesses the success factors related to this destination, that is the determinants of the high TPPI rates for the tourist destination of Cagliari, which is the capital city located in Southern Sardinia and represents the most important municipality in terms of trade and demographic size. It is nationally and internationally well connected thanks to the airport, the port and the marina. Records of the 2012-2013 database indicate that TLSs located in Cagliari are considered among the best-selling destinations by different tourists' typologies.

The spatial clusters of preferences are detected by hot-spot analysis (Getis and Ord, 1992). The location of each TLS allows detecting sites where the preferences of tourists who visited Cagliari are focused on; thus, it is possible to answer questions such as, 'What areas attract the tourists' attention?'. Firstly, a threshold distance of 1,700 meters is identified and the spots by census tract summarized. In the inner areas of the municipality it is observed the high concentration of the TPPI phenomenon (hot spot), while a peripheral residential area, located in Pirri, represent locations where the phenomenon is less intense (cold spot) (Fig. 11)

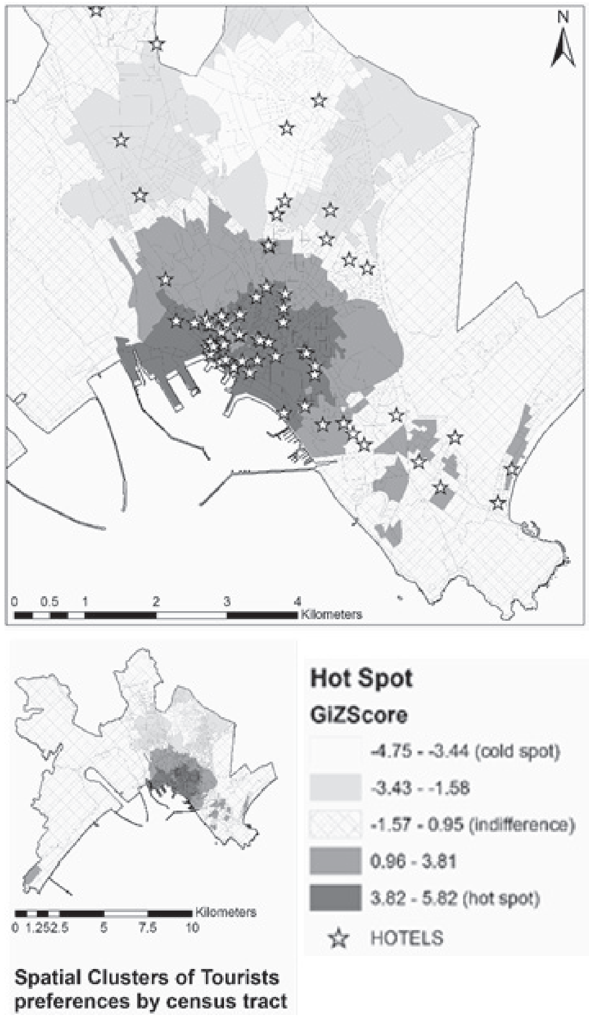

Fig. 11. Cluster of tourists' preferences by census tract in Cagliari

The successive step was focused on each review's content to understand what and where tourists think about Cagliari. Hundreds of textual reviews have been investigated through the textual analysis by location and time, or Spatio-Temporal Textual analysis (STTx). Analyzing tourists' preferences may help in assessing the spatial patterns related to attractive TLSs, to detect useful hints to define sustainable planning policies in terms of tourism development at the local scale. Very interesting results have been obtained by applying STTx to local subsets of data obtained by selecting high TPPI (positive preferences incidence) values based on TLSs' (tourist lodging services) locations.

The tag cloud analysis (Table 3) shows that most the words in the posts refer to spatial or physical aspects of the municipality, such as 'city center', 'beach', and 'church'. The results include keywords related both to leisure sites, such as 'restaurants' and 'shopping', and to services, such as 'staff' and 'room'. High level of satisfaction is also related to accessibility: words as 'proximity' and 'walking' could be related to the TLS' spatial location, natural resources or monuments. So, ease of movement from a site to another produces a positive tourist destination image. In addition, different sectors, such as the business one, within the local community could benefit from the presence of tourists. This is not the kind of information we usually find in land use-related planning documents, but it is powerful in supporting design and decision-making.

TABLE 3: TOP 15 WORDS RELATED TO CAGLIARI DIVIDED BY CATEGORY.

Category	Words [frequency]
Geographic location	location [1010]; town [476]
Natural and non-natural components	city center [426]; beach [378]; church [132]
Accessibility	Minutes [250]; harbor [237]; proximity [164]; walking [146]
Service	staff [890]; restaurant [643]; shopping [459]; room [469]; pool [230]; dinner [180]

4.4. The Change, the Impact and the Decision models

Any design process requires devising courses of action, which aim to change existing situations into preferred ones (Simon, 1969). To achieve the design, the Simon suggests a three-tier iterative workflow of *intelligence* (i.e. the knowledge-base is fashioned), *design* (i.e. the alternative possible future courses of action are devised), and *choice* (i.e. the preferable option, which is selected for implementation). Most spatial planning and Geodesign processes are based on these definitions presented in Simon' approach. Diversely from previous case studies, which demonstrate of how VGI and SMGI can be used as information resources in the representation, process, and evaluation models in Geodesign (i.e. the intelligence phase in the Simon' iterative workflows), the following example highlights how a web-based collaborative platform, with social networking features, can be used to involve a large number of users in collecting volunteered content regarding *design* and *choice* (i.e. change, impact, and decision models in Geodesign).

Social Media are increasingly used to support engineering design and communication (Gopsill et al., 2013) as well as design studio work (Güler, 2015). These platforms are barely exploited to foster collaborative planning and design through the Internet. However, the geodesignhub.com, developed by Ballal and Steinitz (2015), is one example of Social Media platform supporting design in the sense that allows the crowdsourcing of design options so enabling the online implementation of the Steinitz collaborative Geodesign Framework (Steinitz, 2012). Currently, the Geodesignhub.com was successfully applied in several Geodesign workshops around the world (Rivero et al., 2015; Ballal, 2015; Nyerges et al., 2016; Campagna et al., 2016), enabling the seamless collection of design options, namely projects and policies, in the form of georeferenced spatial data diagrams by the involved participants. Following the data collection, the users may take advantage of the platform functionalities to combine diagrams together to achieve complex design syntheses, which may then be compared and assessed by an impact model, directly supplied by the Geodesignhub.com (Fig. 12).

The results of the assessment are useful to highlight in real time both potential positive and negative impacts on the study area, as well as, costs of the design alternatives to participants (Fig. 13).

In addition, the platform supplies several tools to support a negotiation phase among users, which may participate both physically or virtually, to eventually find consensus on a shared future design alternative scenario for the study area.

From an analytical perspective, the data stored in the project geodatabase of the geoidesignhub.com may be certainly considered as VGI. Nevertheless, this information features also SMGI characteristics due to the data model, which consists of spatial, temporal, user and preference dimensions. Particularly these dimensions might be further analyzed to better understand the overall design process and the participants' behaviors and preferences. This approach takes full advantage of ICT technologies and it may be considered a novelty in terms of users' participation modes and crowdsourced data exploitation for supporting spatial planning and design processes.

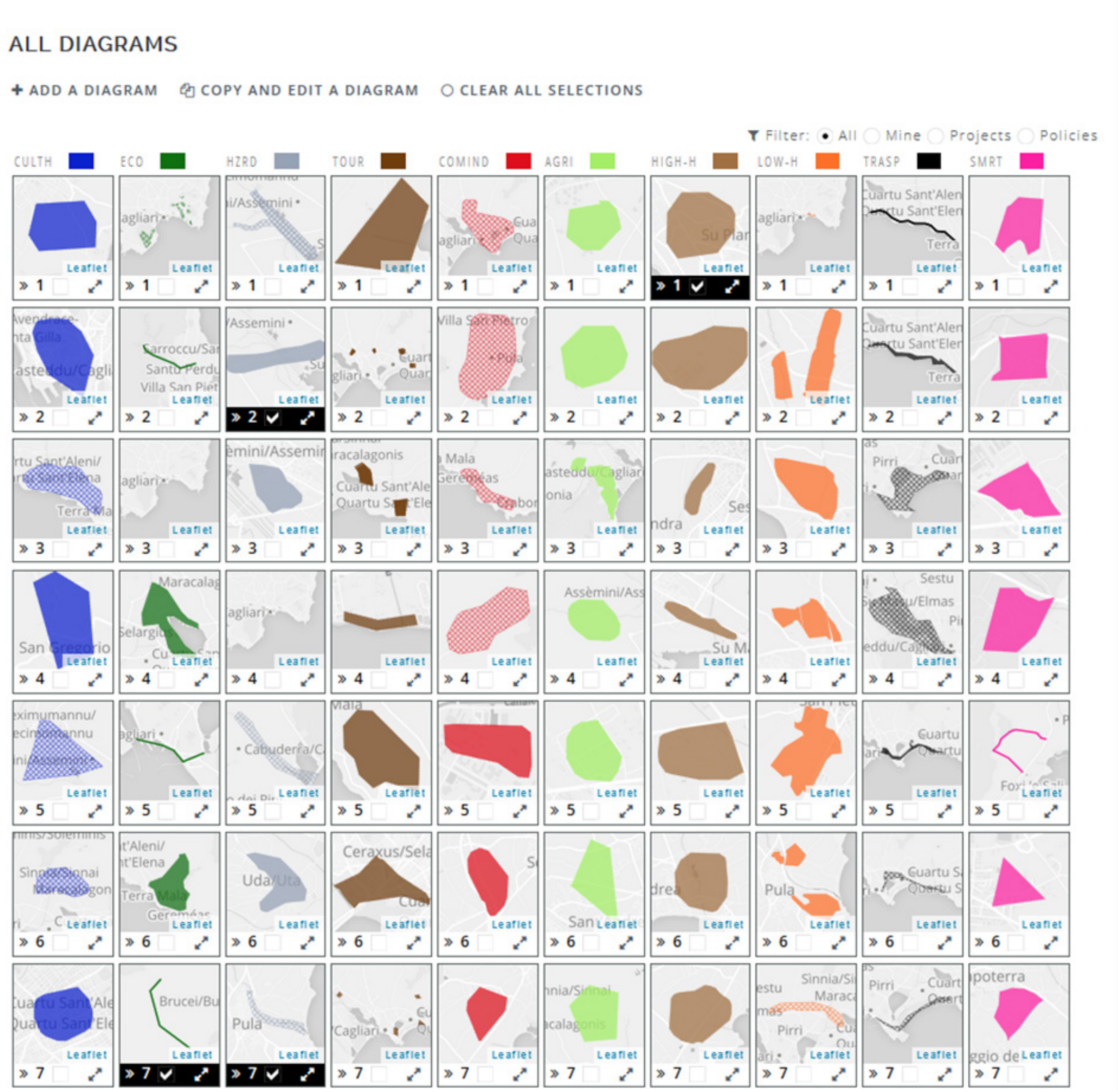

Figure 12. Crowdsourcing project and policy diagrams in the Cagliari metro area at a Geodesign workshop in 2016 with Geodesignhub.com

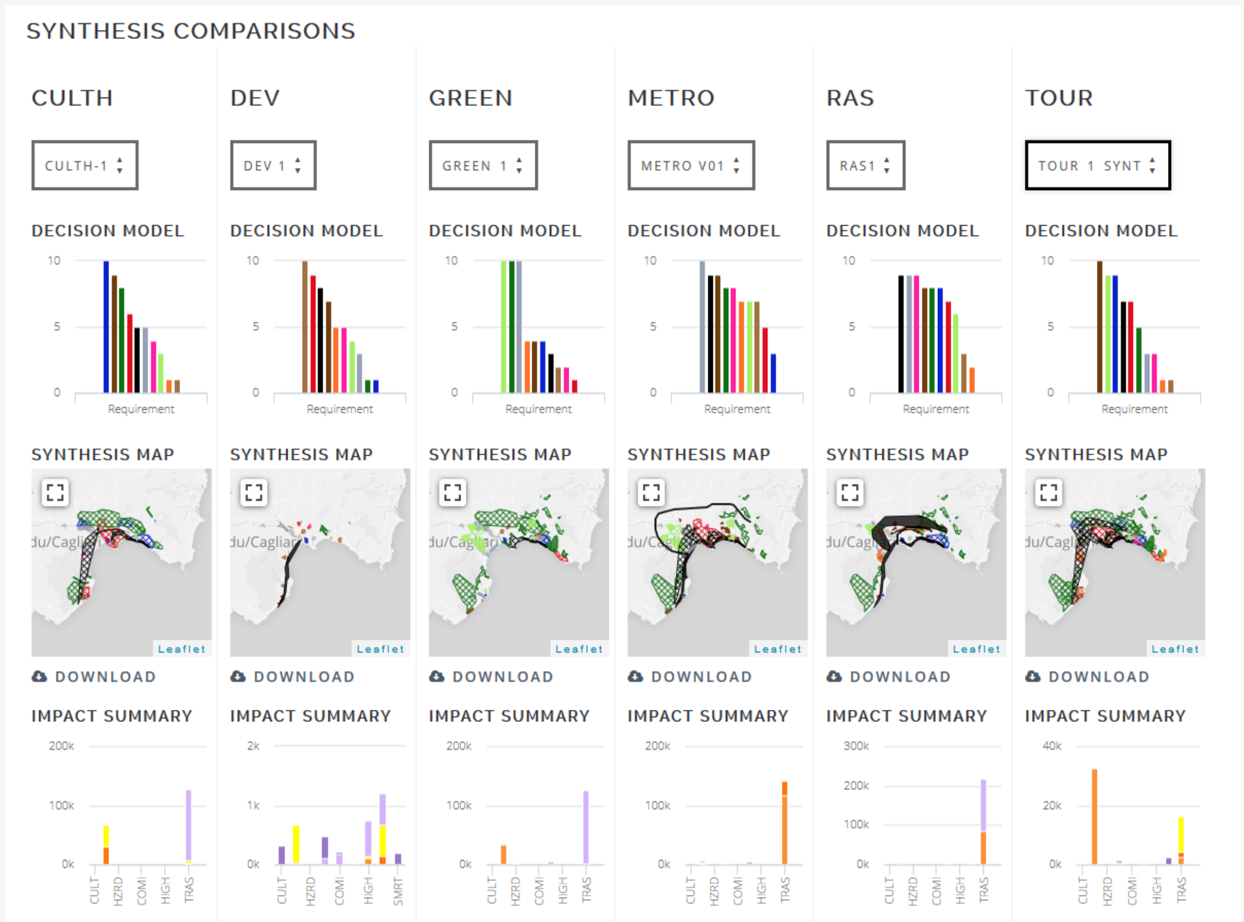

Figure 13. Comparing Geodesign syntheses in the Cagliari metro area at a Geodesign workshop in 2016 with Geodesignhub.com

5. CONCLUSION

The study proposes a methodological approach that exploits a novel source of information, which can be integrated into the authoritative data sources, and successfully used in spatial planning domain, contributing to take into account a multifaceted user' oriented view on strategic development issues. Results obtained through this innovative and integrated approach offer interesting challenges towards the development of specific analysis regarding people spatial and thematic perception of places. Spatial analyses and techniques are provided to demonstrate how SMGI may be used and integrated with A-GI in GIS environment. This integration can disclose analytical opportunities for further scenario analysis in spatial planning, with regards not only to geographic facts measurement but also to users' perceptions and opinions on places and points of interest.

In an integrated planning support framework, SMGI analytics could help to understanding the community' observations, preferences, interests, feelings, and needs. Moreover, it may also affect decision-making dynamics and planning processes with tourists' oriented strategies.

Secondly, this study demonstrates the opportunities of SMGI as support for analysis in spatial planning. In those case studies users' preferences in space and time are analyzed from the spatial perspective through the review collected by several social networks. Results show which the most popular areas are and what users appreciate or disregard. Spatial analysis and statistics techniques are used to describe and visualize the spatial distribution of users' preferences and to detect patterns and hot-spots. The findings provide insights on the city spatial dynamics, which are not available through traditional data sources.

Finally, considering stakeholders' involvement, user' preferences knowledge in supporting the spatial planning processes could represent a significant implication for future research in the field of social sciences and territorial management. Indeed, the analysis of the described case study emphasizes the importance of the users within the inclusive processes. For instance, their behavior can reinforce or discourage the existing power relations.

Thus, the question concerns how the local communities and the political and planning processes are linked. In this field, the study provides different implications for studies regarding the participation theme and in relation to further studies in other research areas. Moreover, other considerations in users' perception, considering the local communities' perceptions, already demonstrate challenging and stimulating research opportunities which may bring innovation to spatial planning, design and decision-making.

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