



Beyond social networks contents: how Social Media Geographic Information may support spatial planning analysis

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Introduction

Since the last 20 years, Information and Communication Technologies (ICTs), the Internet, and more recently the Web 2.0 platforms have fostered the entry of novel technologies into people's daily life. Current innovations are easing the production, the sharing and the access of multimedia contents that are autonomously generated and consumed by millions of users worldwide through web platforms or social networks sites, namely User-Generated Contents (UGCs) (Krumm et al. 2008). The wealth of UGCs, daily disseminated through the Internet, is potentially transforming the Web in a novel source of digital Geographic Information (GI) (Elwood et al. 2012), inasmuch most of the shared contents embed a spatial reference, thanks to the availability of global positioning system (GPS) and sensors in handheld devices, as well as, because of the advanced functionalities for georeferencing offered by geo-browsers or location-based social networks, utilized during contents' production.

This phenomenon is enabling the forecasted convergence of social media and GIS (Sui and Goodchild 2011), facilitating interactions and the building up of constructive dialogues regarding places and social issues among users. Indeed, the broadening of the GI collection, use and diffusion, from a small group of experts to potentially the whole community, may trigger major changes to maps production and consumption (Engler et al. 2014), leading toward new scenarios of

cartographic interactivity (Roth 2013) and, eventually, guiding the renaissance of GI (Hudson-Smith and Crooks 2008). At the same time, the contemporary ICTs diffusion and GI availability may foster noteworthy innovations in spatial planning methodologies and practices, potentially allowing new modes of working, communicating and participating.

Commonly, georeferenced UGCs are referred to as Volunteered Geographic Information (VGI), stressing the voluntary role hired by users for freely collecting and contributing GI related to the geographic world in a bottom-up approach (Goodchild 2007). Particularly, a VGI subset called Social Media Geographic Information (SMGI) (Campagna 2014), namely GI implicitly and/or explicitly produced and shared through social network sites, may disclose notable opportunities for spatial planning analysis, allowing not only the collection of quantitative GI but also the extraction of qualitative data regarding users' perceptions on phenomena in space and time. However, the opportunities for using SMGI in spatial planning methodologies have to deal with major challenges related to data accessibility, management, quality and analysis. In fact, SMGI owns Big Data nature because of huge data volume, fast cycles of production and consumption, as well as, heterogeneous, unstructured and often noisy data streams, and, unfortunately, the traditional spatial analysis methods and techniques may be not fully suitable to address these hurdles to

fully exploit this information in practices. Despite in literature an increasing number of approaches is proposed, the access to SMGI by the public is still rather limited (Lazer et al. 2009) and common methods and tools to take advantage of this information still lack.

In the light of these considerations, the paper investigates the SMGI data model, assessing its inherent differences from traditional vector datasets and focusing on the additional featured dimensions. Afterwards, a number of analytical options, which may be accessible to planners and practitioners to enrich the spatial planning knowledge basis through SMGI, are discussed. In this regard, several examples are provided with reference to a number of case studies carried out by the authors, wherein SMGI is proficiently used to support urban and regional planning analysis. Finally, a critical discussion is drawn from the results, arguing the potential relevance of SMGI for supporting spatial planning and identifying future research agenda.

Methodology

The wealth of SMGI, offering insights on users' concerns and freely accessible through the Internet by social media Application Programming Interfaces (APIs), may disclose opportunities to monitor opinions and perceptions of users about experienced phenomena, as well as, their movements and behaviours in urban environments. However, major issues may limit these opportunities, such as the lack of user-friendly tools to collect and to manage huge unstructured datasets and the particular data model of SMGI, which may be barely processed through standard methods without a loss of information.

While the former issue is starting to be addressed by new tools emerging to deal with Big Data, the latter issue may need the formalization of novel analytics methods in order to fully exploit the contents embedded in the different dimensions of SMGI. As a matter of fact, SMGI is inherently different from usual vector spatial datasets, which contain exclusively spatial and thematic attributes. SMGI data model features spatial, temporal, user and multimedia dimensions, thus extending the range of analytical opportunities. In addition, in certain cases, SMGI supplies a preference dimension too, namely the social networks community's appreciation about a topic, expressed through scores, stars or likes/dislikes, thus further expanding the analysis options (Campagna et al. 2015). Moreover, any web platform used to create and disseminate SMGI may present specific features regarding contents' production and sharing, causing issues in integrating and analysing information collected from different sources. Particularly, the multimedia dimension (i.e. text, picture, audio, video) makes it difficult to properly investigate this information by means of traditional query languages, exclusively. In order to better explain the particular nature of SMGI, Figure 1 shows the graphical representation of a general SMGI data model, identifying the available analytical dimensions and exposing the differences from traditional vector datasets.

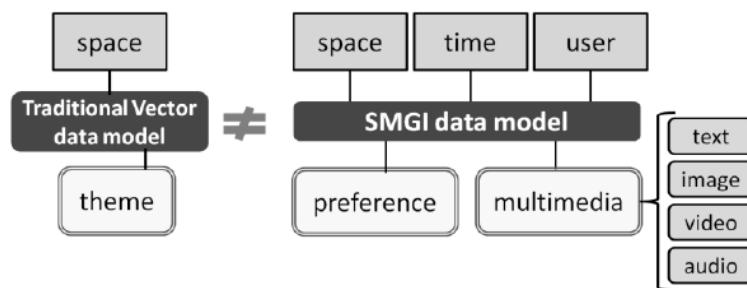


Fig. 1. SMGI data model (adapted from Campagna 2014).

From an analytical perspective, any framework should include not only common spatial analysis methods, but also new tightly integrated methods in order to deal with temporal, user and multimedia dimensions. In this regard, the authors propose a framework to fully exploit SMGI, namely SMGI Analytics, for enriching the knowledge basis about the local context and for supporting spatial planning practices. Operatively, the framework consists of several analytic methods, which may be used in different scenarios for investigating spatial and temporal patterns, as well as users' behaviors, movements and preferences. In the next section, the methods are briefly described with reference to results obtained from several case studies conducted by the authors using SMGI collected from different social media platforms. Despite the differences in the studies' purposes, the first step, required to conduct investigations on SMGI, is always data collection, which is carried out by querying social networks APIs by means of natural language, temporal, spatial and/or user queries. With regards to the case studies presented in

this paper, SMGI data are collected from Instagram, Foursquare, Booking.com and TripAdvisor through spatial and temporal queries, exploiting the functionalities of ad-hoc tools, developed by the authors, to access, extract and manage this kind of data directly in GIS environment.

Results and discussion

The SMGI Analytics framework consists of several methods, which may be used to elicit knowledge useful for different planning scenarios, such as:

- Spatial analysis of users' interests. SMGI may be used to investigate the patterns of users' interest in space by density and/or clustering functions. Overlying official information and SMGI may offer hints to public authorities to understand which places attract the major interest and how they are perceived by users. An example is shown in Figure 2A, where Instagram SMGI is used to detect clusters of highly visited areas in the Poetto Beach of Cagliari municipality, meanwhile Foursquare SMGI is used to identify the venues potentially causing the attraction phenomenon within the identified clusters (Floris et al. forthcoming).
- Spatial statistics on users' preferences. SMGI collected by spatial units may enable the spatial statistic analysis of users' preference. An example is given in Figure 2B, where the hot-spot analysis is applied at the regional scale in Sardinia (Italy) on SMGI collected from Booking.com and TripAdvisor social platforms, to quantitatively study the distribution by municipality of positive users' assessments and to investigate the reasons behind users' preferences for certain specific destinations or areas (Floris and Campagna 2014).
- Multimedia contents analysis. SMGI multimedia contents might be analysed to extract further useful insights. However, albeit currently available texts analytics may enable the investigation of natural language texts, the extraction of knowledge from other multimedia contents is more difficult thus far.
- Temporal analysis of users' patterns. SMGI may allow studying when specific destinations, neighbourhoods, public spaces, or other services are used during different time periods. An example is shown in Figure 3, where Instagram SMGI, related to a public space in the Cagliari municipality, namely the Regional Park of Molentargius and the Poetto Beach, is examined to identify users' utilization patterns of these areas during different periods (Massa 2016). The temporal patterns of weekdays and weekends show notable similarities, while patterns of monthly distribution expose evident differences between summer and winter.
- Users' behavioural analysis. SMGI may enable the investigation of users' behaviours in space and time. Moreover, the user dimension might be used to segment local community's contributors in groups according to common demographic characteristics, preferences and habits, leading toward the potential application of user profiling into spatial planning methodologies (Massa, *ibidem*).
- Combination of several analytical methods. A combination of SMGI Analytics methods may foster to gain further insights about what people discuss and perceive, as well as, how they interact, move and behave both in space and time, allowing in detail investigation of urban environments and local communities (Campagna et al. *ibidem*).

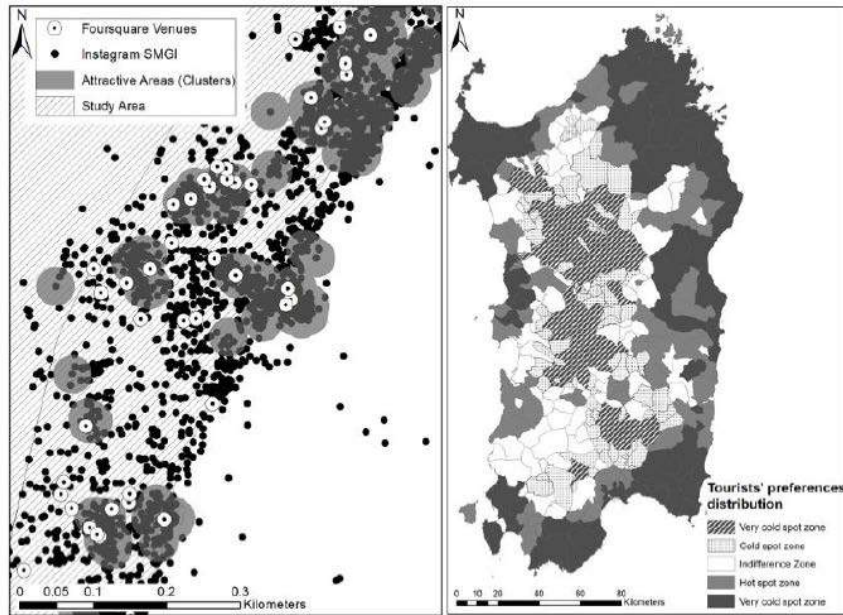


Fig. 2.A. Spatial analysis of users' interests at the local scale. B. Spatial statistics on users' preferences at the regional scale SMGI data model (adapted from Campagna 2014).

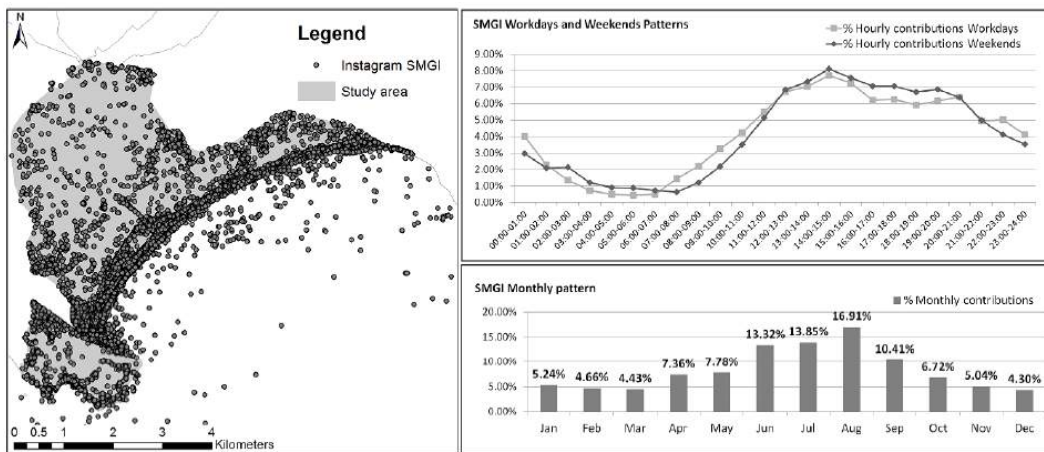


Fig. 2. Temporal analysis of users' patterns

The aforementioned SMGI Analytics methods, as well as the provided results provide a picture demonstrating how this type of information might be proficiently used in spatial planning domain to enrich the available knowledge basis with further information usually excluded from practices. As a matter of fact, SMGI might be used to elicit information, not only about the physical geography of places, but, overall, to gain insights about the perceptions, the concerns and the habits in space and time by the involved community, adding a multifaceted perspective for spatial planning and decision-making.

Conclusions

The contribution discusses the increased availability of SMGI over the global Internet and the opportunities that this type of information may provide to support spatial planning analysis. Currently, the wealth of information enclosed in SMGI may be used to investigate both quantitatively and qualitatively urban environments and local community preferences and habits, greatly extending the range of analytic options.

Nevertheless, in spite of notable opportunities for analysis, it is necessary to be aware that SMGI should not be considered representative of the whole local community. As a matter of fact, social networks are differently used by diverse population groups, which may strongly affect the phenomena under observation with their preferences and cultural biases. Social networks' growth trends suggest that in the future a wider diffusion of these services might occur across all population groups; however, at the time being, different analytical approaches, built upon several platforms, might be required to investigate local context and users' dynamics, appropriately. Furthermore, a number of issues should be further investigated and better understood including the issue of privacy and reliability of shared information. However, early results may be considered very promising and may open alleys for future research streams oriented at fully exploit the SMGI potential in spatial planning practices.

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Table of Content

INPUT 2016 is the ninth meeting with the name INPUT	10
Arnaldo Cecchini	
INPUT 2016 “e-<i>agorà</i>/e-<i>áγopά</i> for the transition toward resilient communities”	11
Giovanni Colombo	
STeHeC - Smart Territories and Healthy Cities	12
<i>The role of urban cyclability in promoting public health</i>	<i>13</i>
Stefano Capolongo, Lorenzo Boati, Maddalena Buffoli, Marco Gola, Alessandra Oppio and Andrea Rebecchi	
<i>Social inclusion and use of equipped public space for physical activity. Analysis and promotion prospects</i>	<i>19</i>
Rossella Maspoli	
<i>Beyond geospatial visualisation: maps for health research</i>	<i>25</i>
Enrico Cicalò	
<i>Urban Form from the Pedestrian Point of View: Spatial Patterns on a Street Network</i>	<i>32</i>
Alessandro Araldi and Giovanni Fusco	
<i>3D Modelling from Urban Environment to Internal Management of Buildings</i>	<i>39</i>
Maurizio Minchilli, Elena Carta, Barbora Slabeciusová and Loredana Tedeschi	
<i>Appropriate Technologies and Deprived Neighbourhoods: Making Technologies Work for Inclusive Urban Development</i>	<i>46</i>
Arnaldo Cecchini, Valentina Talu and Andrea Vesco	
<i>Planning, managing and empowering while pursuing change: integrating community map-making and geographic information technologies</i>	<i>52</i>
Barbara Dovarch	
<i>Flexible Design to Territory Smart User-Centered</i>	<i>60</i>
Cristiana Cellucci and Daniela Ladiana	
<i>Integrated Accessibility: a Macro-Requirement for the Healthy City</i>	<i>65</i>
Filippo Angelucci and Michele Di Sivo	
<i>Environment – Cities – Users: a multidisciplinary approach for the quality of urban spaces</i>	<i>71</i>
Angela Giovanna Leuzzi, Roberta Cocci Grifoni, Maria Federica Ottone and Enrico Prenna	
<i>Walk, See, Know: Modelling Landscape Accessibilities</i>	<i>77</i>
Enrico Cicalò, Arnaldo Cecchini, Nada Beretic, Roberto Busonera, Dario Canu and Andrea Causin	
<i>Recording, management and returning of data for improving accessibility of public spaces by involving users</i>	<i>83</i>
Ilaria Garofolo, Elisabeth Antonaglia and Barbara Chiarelli	
<i>Multilevel Infrastructures</i>	<i>89</i>
Claudia Di Girolamo	
<i>The built environment as a determinant of the public health. An epidemiological survey of the walking behavior in Sardinia</i>	<i>93</i>

Marco Dettori, Andrea Piana and Paolo Castiglia	
<i>Shaping urban pedestrian mobility involving users: the Labac case study</i>	98
Barbara Chiarelli, Silvia Grion and Ilaria Garofolo	
<i>Spatial image of territories. The case study of Sardinia</i>	102
Miriam Mastinu	
<i>An Empirical Study on Factors of Perceived Walkability</i>	108
Ivan Blečić, Dario Canu, Arnaldo Cecchini, Tanja Congiu, Giovanna Fancello and Giuseppe Andrea Trunfio	
<i>GPS Traking and Surveys Analysis of Tourists' Spatio-Temporal Behaviour. The case of Alghero.</i>	114
Ivan Blečić, Dario Canu , Arnaldo Cecchini, Tanja Congiu, Giovanna Fancello and Giuseppe Andrea Trunfio	
<i>Triggers of urban innovation. The Case of Cavallerizza Reale in Turin</i>	121
Roberta Guido	
<i>No more build, but regenerate and reuse</i>	128
Cristiana Cellucci and Daniela Ladiana	
<i>A Reflection on Smart Governance in the new Metropolitan City of Cagliari</i>	135
Chiara Garau, Ginevra Balletto and Paola Zamperlin	
<i>R&S.U.E Resilient & Safe Urban Environment</i>	143
Ester Zazzero	
<i>Planning for S.M.A.R.T. (Specific, Measurable, Achievable, Resilient, Time-bound) development: a bottom up approach to lead knowledge-based tourism development in low density rural districts</i>	151
Tanja Congiu, Maurizio Napolitano and Alessandro Plaisant	
<i>Urban intersections effect on pedestrian accessibility</i>	157
Ivan Blečić, Arnaldo Cecchini, Tanja Congiu, Dario Canu and Giovanna Fancello	
<i>Built environment and health inequalities: results from a European research project and overview of methods for assessing health impacts in urban areas</i>	164
Enrico Eynard, Giulia Melis and Matteo Tabasso	
ESSP - Ecosystem Services and Spatial Planning	170
<i>Graph Representations of Site and Species Relations in Ecological Complex Networks</i>	171
Gianni Fenu and Pier Luigi Pau	
<i>Conflictual issues concerning land uses related to ecosystem services under the provisions of the Habitats and Birds Directives</i>	177
Federica Leone and Corrado Zoppi	
<i>Assessment: land use and capacities to provide ecosystem service. The case study of Tertenia</i> ..	184
Maddalena Floris	
<i>The Natura 2000 Network in the context of the Metropolitan City of Cagliari: an example of Habitat Suitability Approach (part one)</i>	190
Daniela Ruggeri and Ignazio Cannas	

<i>The Natura 2000 Network in the context of the Metropolitan City of Cagliari: an example of Habitat Suitability Approach (part two, continued from part one)</i>	196
Ignazio Cannas and Daniela Ruggeri	
<i>Ecosystem services within the appropriate assessment of land-use plans: exploring a potential integration</i>	202
Sabrina Lai	
<i>Courtyards, Climate regulation services and Nature-based solutions: a modelling approach to support urban regeneration of empty spaces</i>	208
Raffaele Pelorosso, Federica Gobattonia, Francesca Calace and Antonio Leone	
TSC - Towards the Smart City	213
<i>A critical review of parameters within urban sustainability models: how much do soil and natural resources weight?</i>	214
Floriana Zucaro	
<i>The building aspect ratio for an energy efficient green network design</i>	220
Carmela Gargiulo and Andrea Tulisi	
<i>Energy efficiency measures for building and their impact on the grid in a Middle East case study</i>	226
Paolo Lazzeroni, Sergio Olivero, Federico Stirano, Guido Zanzottera, Carlo Micono, Piercarlo Montaldo and Umberto Fabio Cali	
<i>Energy consumption in hospitals: towards a new benchmark</i>	231
Romano Fistola and Marco Raimondo	
<i>Urban Environmental Quality and Sustainability: a proposal for an evaluation method of Neighborhood Sustainable Assessment tools</i>	238
Rocco Papa, Chiara Lombardi and Maria Rosa Tremiterra	
<i>DIPENDE – a tool for energy planning of building districts based on energy performance certification data</i>	245
Ezilda Costanzo, Bruno Baldissara and Marco Rao	
<i>Energy Efficiency and Participation: a double smart approach in LEO project</i>	251
Cristina Marietta, Giulia Melis and Maurizio Fantino	
<i>Identify the sustainable level of local plans and urban sectors. Proposal for an operational procedure</i>	258
Giuseppe Mazzeo	
<i>Key Messages: a decision support system based on the integration between city and mobility</i> .	264
Carmela Gargiulo and Maria Rosa Tremiterra	
<i>Accessibility and built environment surrounding metro stations: a GIS-based comparison of Naples line 1, Milan line 3 and London Jubilee line</i>	269
Rocco Papaa, Gerardo Carpentieria and Gennaro Angiello	
<i>A GIS-based and socially participative procedure for the location of high vulnerability territorial functions</i>	275
Romano Fistola and Rosa Anna La Rocca	

<i>Modelling and Assessing Pedestrian Isochrones around Public Transport Nodes: a People-Centred Perspective towards Smartness</i>	281
Silvia Rossetti, Michela Tiboni and David Vetturi	
<i>Households' willingness to pay in good and bad economy. The case study of Naples</i>	287
Carmela Gargiulo, Simona Panaro and Laura Russo	
SMGI - Social Media Geographic Information and collaborative mapping: exploring new trends in spatial analysis	294
<i>Social Media Geographic Information Visual Analytics</i>	295
Junia Borges, Ana Clara Moura, Priscila de Paula and Pedro Casagrande	
<i>Beyond social networks contents: how Social Media Geographic Information may support spatial planning analysis</i>	300
Pierangelo Massa, Roberta Floris and Michele Campagna	
<i>Social Media Geographic Information for urban space analysis: the case of Expo Milano 2015</i> .	307
Raffaele Gallo, Michele Campagna, Pierangelo Massa and Giovanni Rabino	
<i>The use of SMGI in supporting tourism planning practices: an innovative approach for the municipality of Cagliari</i>	313
Roberta Floris, Pierangelo Massa and Michele Campagna	
<i>Real society in virtual space: a new platform to share responsibilities</i>	319
Lucia Lupi, Alessio Antonini, Guido Boella and Eloheh Mason	
<i>Online tools for public engagement: case studies from Reykjavik</i>	325
Iva Bojic, Giulia Marra and Vera Naydenova	
<i>Comparing Traditional Maps with Twitter-Derived Maps: Exploring Differences and Similarities</i>	331
Stefano Pensa and Elena Masala	
<i>Mapping the food system in Turin</i>	337
Luca Davico, Marina Bravi, Egidio Dansero, Gabriele Garnerò, Paola Guerreschi, Federico Listello, Giacomo Pettenati, Paolo Tamborin and Alessia Toldo	
<i>Crowdmap applied to Geotourism: Case Study of Chapada Diamantina BA - Brazil</i>	344
Pedro B. Casagrande, Nicole Rocha, Priscila Lisboa and Ana Clara Mourão Moura	
<i>MiraMap: an e-participation tool for Smart Peripheries</i>	350
Francesca De Filippi, Cristina Coscia, Guido Boella, Alessio Antonini, Alessia Calafiore, Anna Cantini, Roberta Guido, Carlo Salaroglio, Luigi Sanasi and Claudio Schifanella	
<i>Production of spatial representations through collaborative mapping. An experiment</i>	356
Angioletta Voghera, Rossella Crivello, Liliana Ardissono, Maurizio Lucenteforte, Adriano Savoca and Luigi La Riccia	
UFEPc - Urban Form and Perception of the City	362
<i>THE FRIENDLY CITY [LA CIUDAD AMABLE]. Andalusian Public Space Programme Awareness raising, training and interventions regarding cities, public space and sustainable mobility</i>	
363	

Gaia Redaelli	
<i>Space Syntax applied to the city of Milan</i>	370
Valerio Cutini, Denise Farese and Giovanni Rabino	
<i>Configurational Approaches to Urban Form: Empirical Test on the City of Nice (France)</i>	376
Giovanni Fusco and Michele Tirico	
<i>Physical factors affecting the citizens' security feeling in communal spaces (case study: BandarAbbas city)</i>	383
Ali Shahdadi and Marziyeh Rezanejad	
<i>Conurbations and resilience. When growth makes us fragile</i>	389
Valerio Cutini	
IMPC – ICT Models: Planning for inclusive Communities	395
<i>Virtual Environments as a Technological Interface between Cultural Heritage and the Sustainable Development of the City</i>	396
Georgios Artopoulos	
<i>Visualisation Tools in Grasshopper+Rhino3D to Improve Multi-Criteria Analysis in Urban Policies – Case Study of Pampulha, Brazil</i>	404
Ana Clara Mourão Moura, Suellen R. Ribeiro, Diogo C. Gualdalupe and Silvio R. Motta	
<i>Studies of Volumetric Potential in Pampulha, Brazil</i>	411
Suellen R. Ribeiro and Ana Clara Mourão Moura	
<i>When the parametric modeling reveals a collapse in the future urban landscape: The case of Divinópolis – Minas Gerais/Brazil</i>	418
Diogo de Castro Guadalupe, Bruno Amaral de Andrade and Ana Clara Mourão Moura	
<i>A Spatial Decision Support System for Industrial Re-Use</i>	424
Alessia Movia and Maria Vittoria Santi	
<i>How knowledge subjectivity affects decision-making: a Geodesign case study for the Cagliari Metro Area</i>	429
Elisabetta Anna Di Cesare, Roberta Floris and Michele Campagna	
<i>Knowledge Organization for Community Revitalization: An Ontological Approach in Taranto Industrial City</i>	436
Rossella Stufano, Dino Borri, Domenico Camarda and Stefano Borgo	
<i>Integrating VGI system in a Participatory Design Framework</i>	441
Alessia Calafiore, Junia Borges, Ana Clara Mourão Moura and Guido Boella	
<i>Evaluation of social benefits generated by urban regeneration: a stated preference approach</i>	447
Marta Bottero and Giulio Mondini	
URTL - Urban-Rural Transitional Landscapes	453
<i>Urban-rural-natural gradient analysis using CORINE data: an application to the Italian regions of Friuli Venezia Giulia, Umbria, and Calabria</i>	454

Marco Vizzari, Sara Antognelli, Maurizia Sigura and Giuseppe Modica	
<i>Liveability services in transitional landscapes: a spatial-MCDA model for assessment and mapping</i>	461
Sara Antognelli and Marco Vizzari	
<i>Big data and environmental management: the perspectives of the Regional Environmental Information System of Sardinia, Italy</i>	468
Andrea De Montis, Sabrina Lai, Nicoletta Sannio and Gianluca Cocco	
<i>Quantifying transport infrastructures and settlement fragmentation: strategic measures for rural landscape planning</i>	474
Andrea De Montis, Antonio Ledda, Vittorio Serra and Mario Barra	
<i>Multi-temporal satellite imagery for soil sealing detection and urban growth mapping in the city of Ranchi (India)</i>	480
Andrea Lessio, Vanina Fissore, Barbara Drusia and Enrico Borgogno-Mondino	
<i>Temporal variation of ecological network's structure: some insights on the role of Natura 2000 sites</i>	486
Giuseppe Modica, Luigi Laudaria, Andrea De Montis, Simone Caschili, Maurizio Mulas, Amedeo Ganciu, Leonarda Dessena and Carmelo Riccardo Fichera	
<i>Reducing land take and preserving land quality. A methodology for the application of the Lombardy Regional Law</i>	493
Raffaele Sigon and Giulio Senes	
<i>GIS advanced tools for urban growth reading and management for best practices in town-planning</i>	498
Enrico Borgogno-Mondino and Barbara Drusi	
<i>The bioremediation of polluted areas as an opportunity to improve ecosystem services</i>	505
Lorenzo Boccia, Alessandra Capolupo, Elena Cervelli, Stefania Pindozi, Marina Rigillo and Maria Nicolina Ripa	
<i>Landscape Bionomics: A Comparison Between Two Rural-Suburban Landscapes from Brussels and Milan</i>	512
Vittorio Ingegnoli, Ernesto Marcheggiani, Hubert Gulinck, Fredrik Larouge and Andrea Galli	
<i>Mapping Cilento: Visual analysis of geotagged Twitter data to study touristic flows in southern Italy</i>	519
Ernesto Marcheggiani, Alvin Chuac, Loris Servillo and Andrew Vande Moere	
<i>Association between a spectral index and a landscape index for mapping and analysis of urban vegetation cover</i>	526
Nicole A. da Rocha, Ítalo S. Sena, Bráulio M. Fonseca and Ana Clara Mourão Moura	
MMSD - Methods and Models for Sustainable Development	532
<i>Mobility Flow Estimates at Sub-Regional level: an Application to Piedmont</i>	533
Simone Landini, Sylvie Occelli	
<i>A parametric method to analyze and enhance the cultural heritage and its context</i>	538
Roberto De Lotto, Veronica Gazzola, Cecilia Morelli di Popolo and Elisabetta Maria Venco	
<i>Present State of Inbound Tourism in Japan and Factors of Destination Choice</i>	545