Linking Knowledge to Action with Geodesign

Elisabetta Anna Di Cesare, Roberta Floris, Chiara Cocco and Michele Campagna

Abstract This chapter presents the novel geodesign framework methodology, as proposed by Steinitz (A framework for geodesign. Changing geography by design. Esri, Redlands, 2012), and relevant enabling technology as viable way to innovate spatial planning. Through the detailed description and critical review of a case study on the future development scenarios of the Cagliari Metropolitan City (Italy), the authors aims at demonstrating the geodesign approach may contribute to address some of the most urgent issue of the contemporary planning, as required in Europe by the introduction of Strategic Environmental Assessment. To this end the paper shows how the geodesign framework may link planning knowledge to action, support collaboration for pluralist and democratic decision-making, and ensure that impact assessment is considered during the design. Possible limitations and issues for further research are also discussed aiming at suggesting improvements of the current practice.

1 Introduction

Strategic Environmental Assessment (SEA), introduced by the European Directive 42/2001/EC, promotes a significant methodological innovation in the plan-making process aiming at enriching it with environmental considerations and public participation. Important conditions for SEA to be effective are represented by its inclusive and incremental attitude in defining the objectives of the policies which need to be assessed (Fisher 2003), and the effective participation of all the key actors in the process (Zoppi 2012), both during the preliminary and the *in-itinere* evaluations (Brown and Thérivel 2000). However, many difficulties are often found by professionals on the proper implementation of these principles (De Montis et al. 2014), especially in

E. A. Di Cesare (✉) · R. Floris · C. Cocco · M. Campagna
DICAAR, Università Degli Studi Di Cagliari, Cagliari, Italy
e-mail: elisabetta.dicesare@unica.it

R. Papa et al. (eds.), *Smart Planning: Sustainability and Mobility in the Age of Change*, Green Energy and Technology,
https://doi.org/10.1007/978-3-319-77682-8_11

setting a democratic process, in finding compromises during the participation phase and in consensus building (Zoppi, ibidem).

Geodesign may offer a viable contribution to address these pitfalls. It can be defined as a process for integrating methods, techniques and geo-information technologies, with the goal of supporting planning the physical evolution of the territory. It entails an integrated, collaborative and participatory approach that starts from the conceptualization of the project and continues with data analysis, process simulation, suggestion of alternatives, evaluation of impacts towards the final choice (Steinitz 2012).

Geodesign is currently receiving growing international attention in the field of landscape and urban planning, thanks to the advances and diffusion of cutting-edge information and communication technology introducing new potential for knowledge building and decision support.

Against this background, and in order to explore the potential of the geodesign methodological approach for bringing innovation into planning and SEA practices, we present the results of the international "Geodesign Workshop on Future Scenarios for the Cagliari Metropolitan Area", held in May 2016 at the University of Cagliari, from the workshop preparation phase to the elaboration of alternative design proposals. This case study shows the potential of the geodesign methodological approach to develop both environmental savvy decision-making and efficient collaboration processes, as required by the SEA.

The paper is structured up as follows. The next section gives a brief overview of the geodesign methodological approach and its application within the workshop workflow. The third paragraph describes all the pre-workshop activities: from the definition of the development objective for the metro area and the underlying scenario, to the representation of the territorial context and the evaluation of its dynamics. Paragraph four briefly describes the main steps in the workshop, and the last section concludes with a discussion on the geodesign potential to bring innovation into planning practices.

2 The Geodesign Methodological Approach

Geodesign, intended as a methodological approach to decision making informed by territorial knowledge, allows promoting multidisciplinary collaboration and participation. Geodesign workflows can be applied to urban and regional planning in order to understand how the context should be transformed in the future, according the geodesign framework (GDF) proposed by Steinitz (2012), whose core consists of six models. The first three models describe the study area before the implementation of the plan: based on a detailed description of the study area (Representation Model—RM), the evolution trends of the main territorial dynamics are investigated (Process Model—PM) and then assessed in order to evaluate possible opportunities and risks for proposed transformations (Evaluation Model—EM). The last three models consist of a design stage in which, starting from the identification of possible alternatives for change (Change Model—CM), and their impact assessment (Impact Model—IM), it is possible to choose a final agreed plan (Decision Model—DM). As such, the initial three models represent the assessment phase while the last three models constitute the intervention phase (Steinitz, ibidem).

With these respect, the GDF shows a consistent logic with SEA, which should be run since the early stages of the planning process in order to inform decisions at any step, and it may contribute to address many current SEA pitfalls encountered in the urban and regional planning practices (Campagna and Di Cesare 2016), and relating to the shift from knowledge to action, including the frequent lack of collaborative processes and plan alternatives design.

In order to test the potential of the geodesign framework to a planning case study, the GDF was applied during all activities of the Cagliari metro area futures scenario design, and it served as a guide for the workshop workflow since the very beginning of the process (Table 1).

The workshop is enabled by an advanced technology called Geodesignhub, a web-based collaborative planning support system (https://www.geodesignhub.com) which allows to implement the intervention models of the Steinitz' geodesign framework. In Geodesignhub projects and policies can be drawn in form of geo-referenced vector diagrams (i.e. line and polygons) so creating a matrix of possible transformation options. The latter, which are shared among the participants involved in the design collaboratively, can be then selected by stakeholder design groups to compile complex change proposals, or *syntheses*, which represents alternative plans proposals. The input data for a Geodesignhub project supporting the workshop are depicted with GIS procedures with which the models of the assessment phase are prepared.

3 The Workshop Preparation

While the core workshop activities involving the collaboration of the stakeholder groups involved in the geodesign study were carried-on in the two intensive days focusing on the intervention phase of the study, the local coordination team, responsible for the workshop preparation and consisting of senior and young researchers of the UrbanGIS Laboratory (i.e. experts in architecture, planning, environmental engineering and geo-informatics) worked beforehand with the conductor focusing on the assessment phase.

The Cagliari metropolitan city, located in the southern coastal part of Sardinia (Italy), was established through the Sardinian Regional Law n. 4/2016 including 17 municipalities, for a total population of approximately 420,000 inhabitants. The intrinsic economic vocation of the area include a rich variety of agricultural and fishery activities and, thanks to its natural and cultural landscapes together with improvement in the air-transport and accommodation offer, the area recently became one of the most important tourist destination of Sardinia.

One of the first stages during the workshop preparation was the definition of underlying scenario for the development of the Metropolitan City within a 25-year

Table 1 The geodesign methodological approach applied to the workshop workflow

GDF model	Process phase	Actors	Activities
RM	Workshop preparation	Local coordination team	Legislation framework review Choice of the 10 systems to be represented as design support structure Data collection and analysis
PM	Workshop preparation	Local coordination team	Analysis of territorial dynamics for each system
EM	Workshop preparation	Local coordination team	Creation of the evaluation maps of the 10 selected systems
CM	Workshop	WS participants	Design of conceptual projects and policies proposals related to each system as georeferenced diagrams in Geodesignhub Selection of diagrams and creation of 6 different development synthesis in Geodesignhub
IM	Workshop	WS participants	Real-time impact assessment of the six synthesis in Geodesignhub
DM	Workshop	WS participants	Negotiation towards a final agreed scenario with a sociogram and Geodesignhub

time frame, pursuing the overall goal to create new job opportunities and to promote a new sustainable tourism model. The objectives entailed in this scenario include: development opportunities in tourism, agribusiness, and the creation of an ICT industry pole, together with the essential sustainable transport system improvement, risk prevention, and residential and commercial land-use patterns balancing in the shift of the development scheme from the municipal to the metropolitan scale.

In addition, the local coordination team dealt with the territorial knowledge acquisition and evaluation, including data collection and integration, interpretation and analysis, in order to represent the territorial context in a consistent format with the Geodesignhub input requirements.

3.1 The Context Representation: The Choice of the Ten Systems

The representation of the study area commonly constitutes the first stage of a planning study and it constitutes the first model of the geodesign framework. In the Cagliari case study, the territorial knowledge was structured in ten systems, which were analyzed with the aim of providing common background information to all participants as a base for the design. The choice to describe the main opportunities and risks for the transformation of the land using ten systems was a reasonable compromise: ten is a number big enough to satisfactory represent the main features of the study area and limited enough to enable to handle the territorial system complexity.

The choice of the themes to be represented and the main characteristics to analyze, was strongly influenced by the scale of the study. Accordingly, the first step was the screening of the main national and regional legislation framework and in particular:

- The Sardinian Regional Spatial Planning Law (L.R. n. 45/1989), aiming at planning the use of the regional territorial resources at all levels and at regulating land-use modification interventions.
- The Legislative Decree on organization and responsibilities for Local Authorities (D.Lgs. 267/2000).
- The Sardinian Regional Landscape Plan (PPR-NTA Art. 106, 2006), which pursues the aim of preserving, protecting and enhancing the environmental, historical, cultural and local identity of the whole Sardinian territory, and to promote sustainable forms of development, thus it represents a framework for local land-use planning.
- National law on metropolitan areas, provinces and union of municipalities (L. Delrio 56/2014).

The main objectives affecting the future development of the metropolitan area, defined by regulatory framework, are summarized in Table 2. They are primarily related to the coordination of activities, as well as works, of major supra municipal interests in both the economic, productive, commercial and tourist sectors, as well as in the social, cultural and sport sectors.

The choice of the 10 themes was strongly affected by development goals previously defined. Three of them assess vulnerability elements: cultural heritage (CULTH), ecology (ECO), hydrogeological hazard (HYDRO); the last seven systems devise opportunities for development, or attractiveness, elements: tourism (TOUR), agrifood (AGRI), transports (TRASP), low density housing (LOW-H), high density housing (HIGH-H), commerce and industry (COMIND), smart services (SMRT).

Within the workshop context, that was a research study, the choice of the ten systems was made by the coordination team, playing the role of local expert. In a real case study the choice could have been made according to the SEA regulation requirements, by representatives of the local authorities and of the relevant authorities in environmental matters (i.e. scoping phase).

Table 2 The selection of the systems to be represented according to the legislation framework review

	Systems	Reference regulations	Related environmental systems	Vulnerability (V) or Attractiveness (A)	Objective	Selection
1	Hydrogeological hazard	D.Lgs.267/2000 NTA-PPR Art. 106	Soil, water, settlements, climate change	V	Soil protection, settlement safety in relation to floods and landslides	✓
2	Water bodies	D.Lgs.267/2000 NTA-PPR Art. 106	Water	V	Water resource protection (water body quality)	
3	Desertification	NTA-PPR Art. 106	Soil, climate, land-use	V		
4	Fire hazard	NTA-PPR Art. 106	Soil Flora, fauna and biodiversity Settlements	V	Fire prevention, with particular reference to forests and urban areas	
5	Industrial accident hazard	NTA-PPR Art. 106	Economic and productive sector Settlements	V	Settlements safety/human health	
6	Ecology/bio-Habitat	D.Lgs.267/2000 NTA-PPR Art. 106 L. Delrio 56/2014	Flora, fauna and biodiversity	V/A	Identification of protected areas, natural habitats, flora and fauna species of community interest Identification of ecological corridors in order to allow the connection among protected areas, habitats and natural areas, rivers and wetlands	✓

(continued)

Table 2 (continued)

	Systems	Reference regulations	Related environmental systems	Vulnerability (V) or Attractiveness (A)	Objective	Selection
7	Cultural heritage	L.R. n. 45/1989 D.Lgs.267/2000 NTA-PPR Art. 106	Landscape, historic and cultural resources	V/A	Protection and/or promotion of the historic and cultural resources	✓
8	Transportation	L.R. n. 45/1989 D.Lgs.267/2000 NTA-PPR Art. 106 L. Delrio 56/2014	Mobility	A	Transport Infrastructures and services development	✓
9	Tourism	NTA-PPR Art. 106	Economic and services sector	A	Coordination and promotion of economic and social development, ensuring support for innovative business initiatives, consistent with the metropolitan area vocation	✓
10	Housing	L.R. n. 45/1989 NTA-PPR Art. 106	Settlements Economic and productive sector	A	Coordination of municipal initiatives aimed at residential settlements identification	✓
11	Industrial/commercial	L.R. n. 45/1989 NTA-PPR Art. 106	Economic and productive sector	A	Coordination of municipal initiatives aimed at productive districts identification	✓

(continued)

Table 2 (continued)

	Systems	Reference regulations	Related environmental systems	Vulnerability (V) or Attractiveness (A)	Objective	Selection
12	Social/cultural/sports facilities	L.R. n. 45/1989 NTA-PPR Art. 106	Settlements Economic and productive sector	A	Integrated metropolitan area services management	✓
13	Energy/renewable energy	D.Lgs.267/2000	Energy	A	Renewable energy resource exploitation	
14	Waste management	D.Lgs.267/2000	Waste	A	Ensure an efficient waste disposal system	
15	Health services/schools	D.Lgs.267/2000	Settlements	A	Management of health and education services	✓
16	Land capability classification (agricultural productive soils)	L.R. n. 45/1989	Soil Economic and productive sector	A	Coordinated management of agricultural land uses	✓

3.2 From the Representation to the Evaluation Model

This section reports on how the maps representing the EM of two of the ten systems were created in a GIS environment. Each system was analyzed starting from the description of its current condition (i.e. RM) to the assessment of its territorial opportunities for change or conservation (i.e. EM), in order to give to the workshop participants ten evaluation maps of all the selected systems, as a base for the design activities (i.e. CM). All the EM maps were created in a GIS environment integrating several geographic datasets as input for a land suitability or risk analysis.

The construction of the first system reported here concerns the "Cultural Heritage" (CULTH), which identifies the most vulnerable areas (i.e. risk) in relation to the concentration of the most significant historical assets. The second system is the "Tourism" (TOUR), which identifies the most attractive areas (.i.e. suitability) to undertake tourism development. The data sources used for the evaluation maps creation includes official datasets, or Authoritative Geographic Information (A-GI), retrieved from the regional Spatial Data Infrastructure (SDI), as well as social media geographic information or SMGI (Campagna 2014) such as Panoramio.com georeferenced posts, and Booking.com hotels customers preferences. As a matter of fact SDIs faced prosperous development worldwide in the last decade and in many European regions give accessibility to spatial data for the wider public in order to support informed decision-making (Campagna and Craglia 2012). However, the use of SMGI may enrich the insight potential of AGI for, if properly analysed, (i) it supplies real-time proxy data on citizens movement in and usage of places, and (ii) it gives hints of user interests and preferences.

The integrated analysis of AGI and SMGI was carried on applying the SMGI analytical framework proposed by Campagna (2016) (Massa and Campagna 2016). As argued also by Briassoulis (2002) a relevant knowledge regarding economic, sociocultural and environmental activities in destinations, for better investigating tourism phenomenon, is necessary. In this perspective, SMGI could provide a meaningful information and discloses opportunities for building analytical scenarios related to urban and regional planning.

CULTH, as a vulnerability system, identifies the areas affected by the major spatial distribution, density and proximity to the cultural heritage sites and artefacts to be protected for their historical value, according to the Sardinian Regional Landscape Plan (RLP). The data used to define the RM of the CULTH system (Fig. 1) is retrieved from the regional SDI in digital formats, and it represents the cultural and historical heritage assets in the area.

Specifically, these areas include:

- historic city centres;
- cultural goods (i.e. the combination of historic architectures and the archaeological sites);
- archaeological industrial areas related to the production processes of historical relevance (e.g. the Geological Mining Park and the historic saltworks).

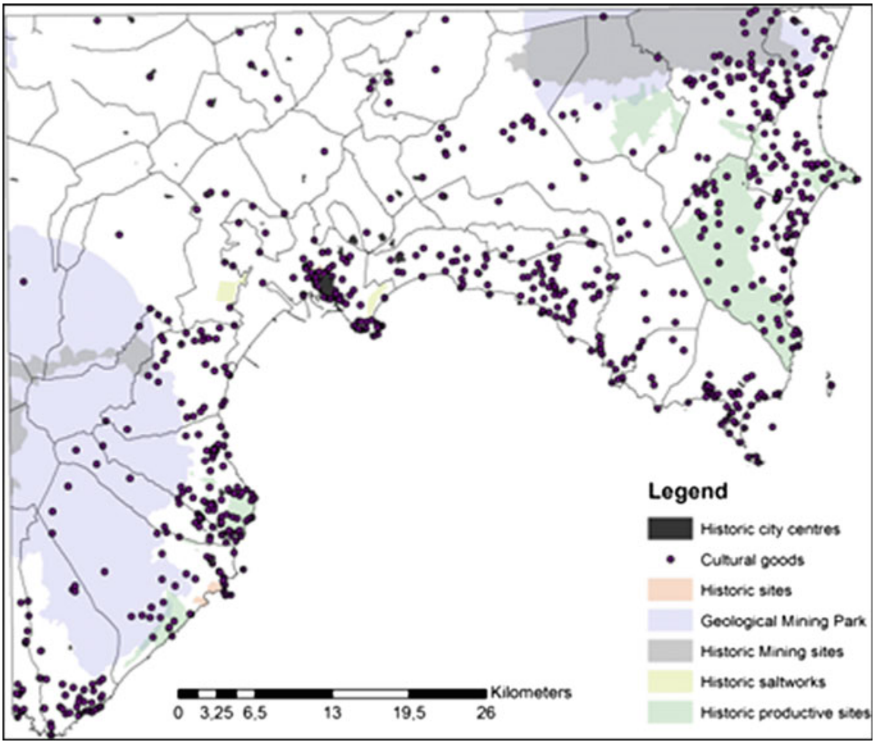

Fig. 1 Representation model of the CULTH system

In order to obtain an EM map of the CULTH system, each dataset is considered as a locational criterion. The CULTH map is implemented in order to describe spatial distribution of historical areas to be protected for future preservation strategies within the Metro area. Firstly, the historic city centers are given the highest vulnerability score, while a decreasing weights are assigned to two buffer zones of influence around them: the first buffer zone extending up to 300 m away from the site/artefact and the second one up to 1500 m. Secondly, a kernel density is implemented for points representing the cultural goods distribution, in order to identify the areas affected by their highest concentration. Lastly, the historical industrial sites are identified and assigned a vulnerability score (Fig. 2).

Each criterion was assigned a weight depending on its susceptibility, and consequently its need for protection: historic city centers and cultural assets have the highest weights, while the historical industrial sites the smallest one, for their lesser vulnerability. The final map was generated combining all these criteria together (Fig. 5a), also on the basis of the context knowledge of the local team, playing the role of local expert.

TOUR represents an attractiveness system, which depicts the spatial distribution of tourists' preferences regarding existing Tourism Lodging Services (TLS) as well as

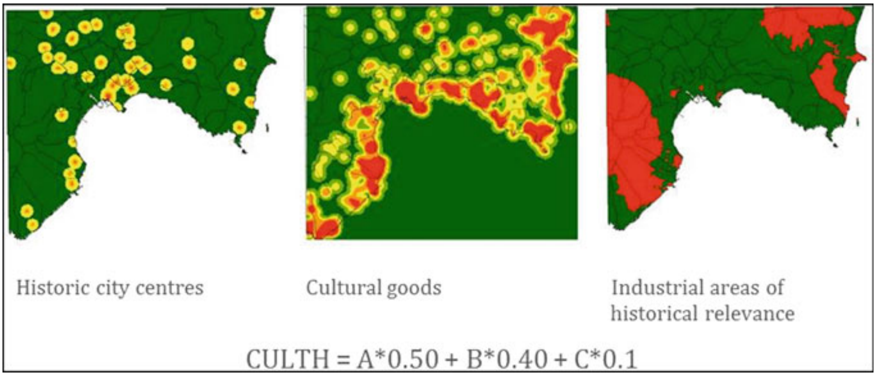

Fig. 2 Process model of the CULTH system

natural and non-natural resources. The innovative aspect of this map is the fact that it includes and represents, thanks to the use of SMGI, tourists' and local communities' perceptions and opinions, spontaneously generated by users (Goodchild 2007).

In fact, understanding the tourists' perceptions and opinions, and integrating this information with traditional A-GI, may represent an opportunity of great potential to enrich sustainable tourism goals with a broader, deeper and more multifaceted understanding of tourist destinations. With an improved awareness of the users' preferences, decision making can be simplified (Leslie et al. 2007) by emphasizing the strengths of tourist destinations for past and potential visitors.

In the light of these considerations, the RM of the TOUR system (Fig. 3) includes the spatial patterns of the following three key elements:

- The existing TLSs and their relative perceived quality, as retrieved from TripAdvisor.com and Booking.com. This dataset includes quantitative information concerning the TLSs scores based on rankings, divided into several categories, such as value/price, rooms, location, cleanliness and sleep quality.
- The already planned tourist areas, or "F areas" as defined by the 2266-U/83 Regional Decree. Data comes from the Municipal Master Plans of the 17 municipalities included in the Metro area and from the Sardinian RLP.
- The georeferenced users' image posts on Panoramio.com, considered as points of interest, from which it is possible to elicit the local landscape, and the visitors' perceptions of natural and historic and cultural resources.

The TOUR system evaluation map was built in order to describe spatial patterns of tourists' preferences and to identify locations of interest for future tourism development strategies within the Metro area. In order to obtain an evaluation map of the areas suitable for tourism development, three different criteria were defined, relying on the three spatial criteria described above. Firstly, a kernel density is implemented for points representing the spatial distribution of tourists' preferences, in order to identify the areas affected by their highest concentration. Secondly, the existing F areas are identified for the 17 municipalities comprising the Metro area and treated

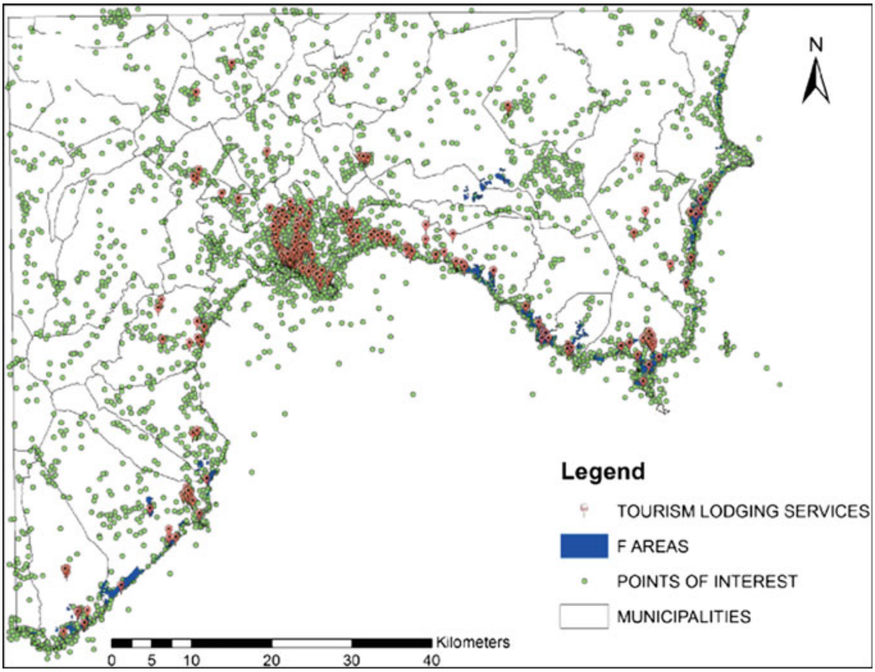

Fig. 3 Representation model of the TOUR system

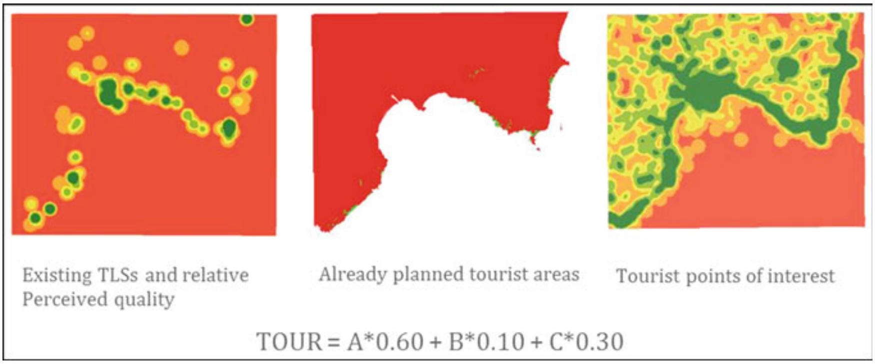

Fig. 4 Process model of the TOUR system

as a boolean variable. Finally, a kernel density is implemented for points concerning the users' contributions on landscape, natural and non-natural resources perception (Fig. 4).

Applying this model, the evaluation map was generated (Fig. 5b), by assigning different weights to each of the three criteria, considering their relative importance, and combining them together. More specifically we consider the presence of tourism

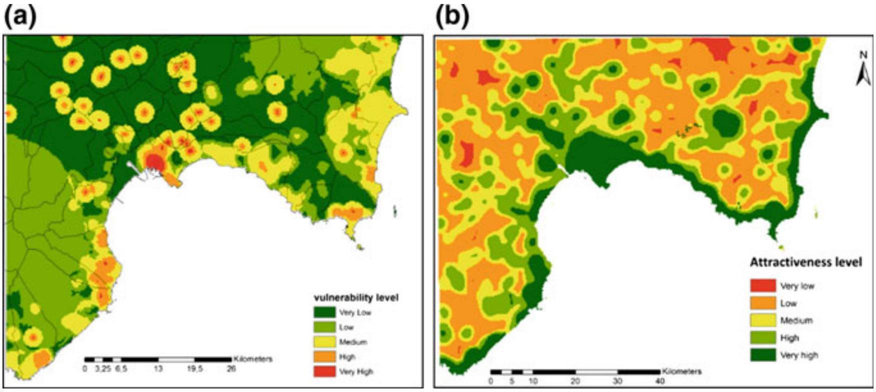

Fig. 5 Evaluation models of the CULTH (**a**)and TOUR (**b**) systems

facilities, accommodation and high tourists' satisfaction level with regards to location, as the most important factors for determining the attractive areas to implement appropriate tourism strategies. For this reason we assign the highest weight to the spatial distribution of tourists' preferences, which indicates the high tourism vocation of a specific area, while the users' perceptions on landscape and resources and existing F areas were assigned a medium and the smallest weight, respectively. Indeed, Municipal Master Plans regulations on the F areas, may not correspond to the real people' perception of places.

The result of the analyses of the EM of the CULTH system is a thematic map which classifies the study area in 5 vulnerability levels, where red areas indicate those characterized by a very high vulnerability, in which only actions aimed at preserving and promoting these sites can be permitted. To the contrary, the dark green areas are the less vulnerable ones, in which do not persists any restriction in use. Whereas in the TOUR system, the final evaluation map classifies the territory into 5 levels, with a color ramp where green color identify very high attractiveness areas for developing tourism development actions, thanks to the presence of existing tourism facilities, accommodations, scenic values and high users interest level for the area. Conversely, areas affected by very low attractiveness, due to the lack of tourism facilities, users' interest and very low accessibility, are depicted with the red color.

Applying the same methodology and the same classification and color code, the local coordination team produced the other eight evaluation maps related to the remaining systems. In Fig. 6 the whole set of evaluation maps given as input to the workshop participants is shown.

According to McHarg (1969) each place is a sum of natural processes to which corresponds social values. In order to respect these values it is important to identify the intrinsic vocation of a territory. The EM pursues this objective, but it is strongly influenced by the cultural and scientific knowledge of the those who create the model and by their role in decision making. As a matter of fact, maps can vary considerably

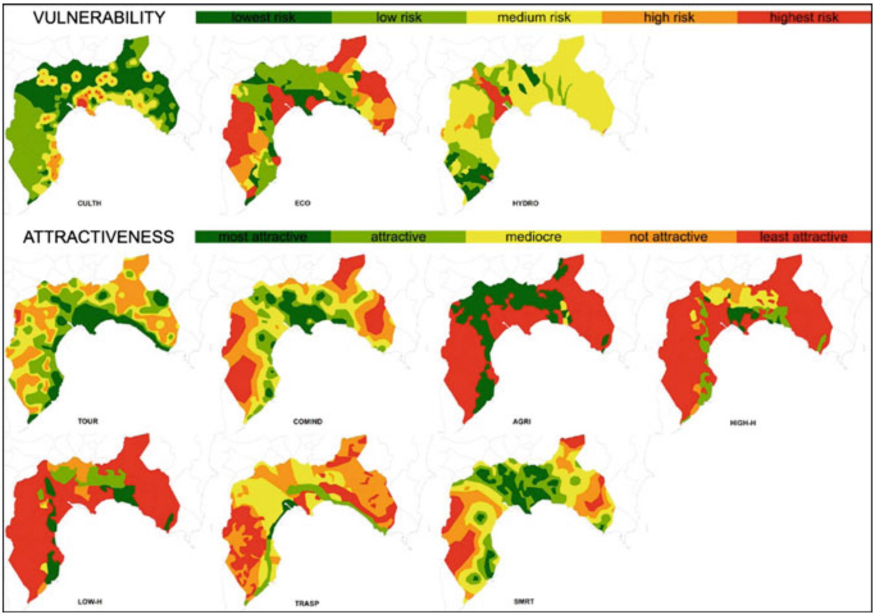

Fig. 6 The ten evaluation maps in the geodesign Workshop

in function of the data collected to describe a specific phenomenon, the criteria analyzed and their respective weights, the suitability/risk function and the modeling tools implemented and, inevitably, all these criteria relies on the planners' expertize. Since the output of the EM, in a geodesign study, provides the knowledge base for the design of alternative plans (CM), the decision-making process is strongly influenced by its results. Considering a real-world planning studio, a subjective perception of phenomena may affect deeply the decision making stage, influencing the shape of the final plan. Hence, an inclusive, participatory and multidisciplinary approach is fundamental in order to ensure a more democratic and transparent process during the definition of the EM. This position is clearly promoted by the 2001/42/EC Directive, which identifies as a primary goal of the SEA the definition of the more appropriate way to represent all the interests of involved parties, and especially to find as many agreement as possible so that all the key-actors' needs are represented in the decision-making processes.

Lastly, the local coordination team compiled and uploaded as input in the Geodesignhub platform a cross-systems impact matrix in order to qualitatively identify the impacts, from the most positive (value +2) to the most negative (value −2), of each single change action over the ten systems (Fig. 7), allowing the calculation and the visualization during the workshop in order to have real-time feedback of each design proposal.

SYSTEM EXISTING CONDITION

System #	SYSTEM CHANGE	1 CULTH	2 ECO	3 HYDRO	4 TOUR	5 COMIND	6 AGRI	7 HIGH-H	8 LOW-H	9 TRASP	10 SMRT
1	CULTH	0	0	0	2	-1	0	-2	-1	-2	-1
2	ECO	0	0	1	0	-1	-1	-2	-1	-1	1
3	HYDRO	-2	1	0	1	1	2	1	1	1	1
4	TOUR	-2	-2	-2	0	2	1	-1	-1	2	0
5	COMIND	-2	-2	-2	-2	0	-1	1	0	-2	-1
6	AGRI	0	-1	-1	2	1	0	-2	-1	-1	0
7	HIGH-H	-2	-1	-2	-1	2	-2	0	-2	-2	1
8	LOW-H	-1	-2	-1	-1	1	-2	-1	0	-1	0
9	TRASP	-2	-2	-2	2	2	1	2	2	0	2
10	SMRT	-1	-1	-1	0	2	-1	2	1	-2	0

IMPACT MODEL	
2	most positive, best
1	positive, good
0	neutral
-1	negative, bad
-2	most negative, worst

Fig. 7 Cross-systems impact matrix

4 The Workshop Workflow

The 2 days geodesign workshop was attended by the 32 participants with diverse backgrounds: researchers from several universities, students from architecture and civil engineering, public administration officials from the Sardinia Regional Government's Planning department and independent professionals (i.e. engineers, architects, agronomists). During the workshop the conductor was responsible for managing the timeline of all the activities and encouraging much as possible an effective communication among all the participants.

At the very beginning of the workshop each participant had a computer available to login and get familiar with the online platform Geodesignhub. The local coordinator introduced the study area and the earlier preparatory work for the workshop and explained the building of the ten systems aimed at representing a common knowledge basis for the participants on the base of which they could start design. As a first stage the participants, grouped in 10 teams, one for each system, were asked to producing a set of geo-referenced diagrams, representing change proposals (i.e. a project or a policy) related specifically to the system they were in charge of. To this end, the platform offers a sketch planning tool for drawing within the study area lines or polygons and for visualizing these changes in the geographic space in real time. The diagrams created in this first stage were around 200 and they were systematically organized by the software in the chronological order of creation into a matrix, where each column represent a territorial system (Fig. 8).

By the end of the morning, participants were divided into six teams, each one with a specific strategic role within the decision process, in order to consider the

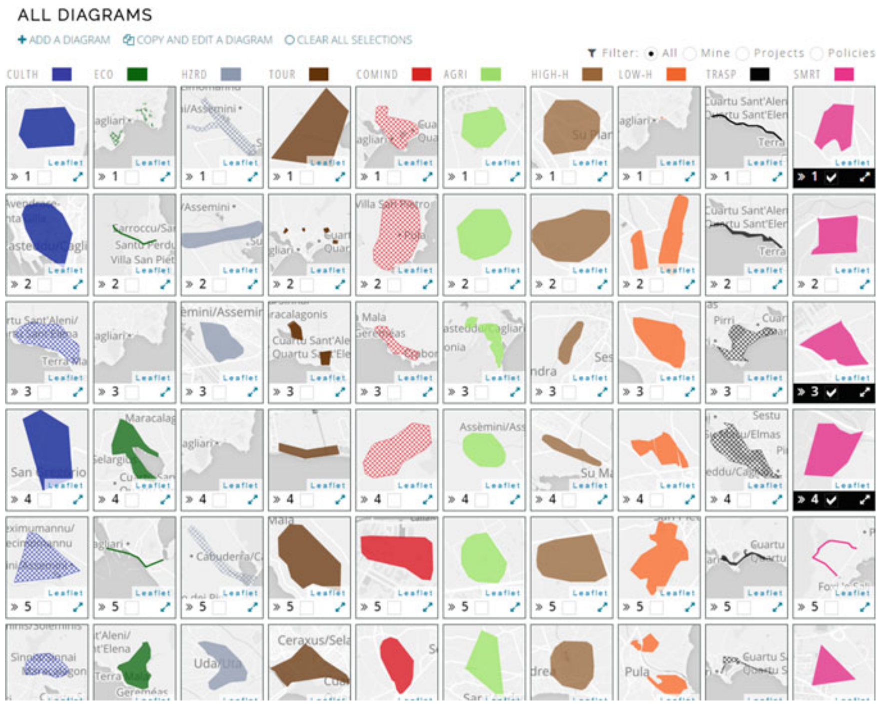

Fig. 8 Project and polices diagrams

outlook of diverse stakeholders from the Institutions, the private sector, NGOs, and other groups of interests, as listed below:

- METRO: Metropolitan government
- RAS: Regional Government of Sardinia
- GREEN: Green (NGO)
- CULTH: Cultural Heritage Conservation
- DEV: Developers
- TOUR: Tourism Entrepreneurs

They were asked to prioritizing the ten systems according to their specific role, expertize, and preferences and to selected a collection of projects and policies among the ones previously designed, in line with their development goals and interests. This way the first plan alternative draft (or syntheses) were created. Hence, the first 6 different syntheses, one for each group, were created. The online platform not only supports rapid syntheses creation, but it also computes real time impacts with a series of maps and histograms showing the direct impact of the proposed changes in each of the systems on a three-classes ordinal scale from positive (i.e. purple) to neutral (i.e. yellow), and negative (i.e. orange). The possibility of visualizing the performance of each alternative synthesis represents one of the central advantages of using digital

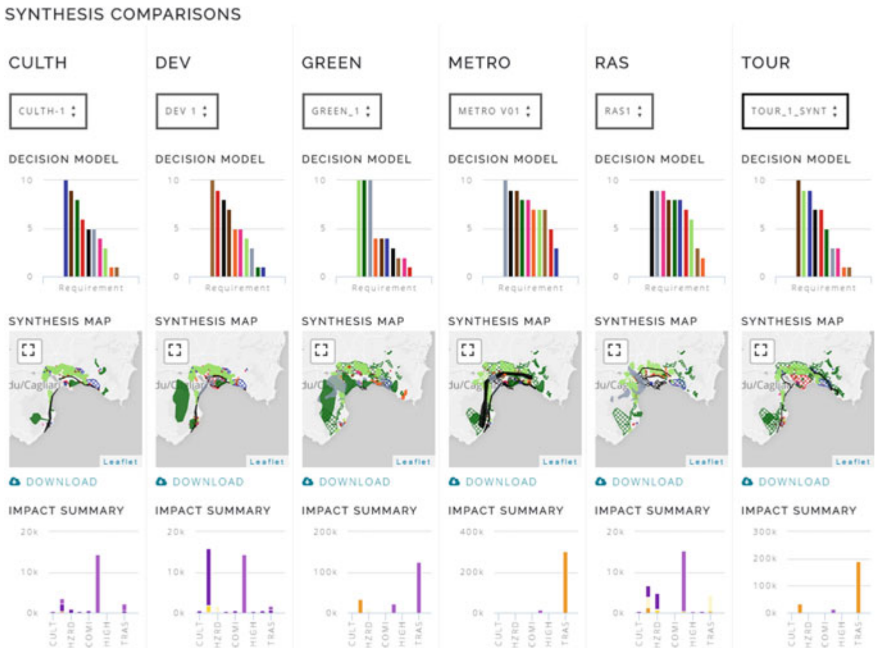

Fig. 9 The scenarios comparative tool showing the impacts performance of the six designs

geodesign technologies for it enables the dynamic revision of the change models through agile trial-and-error iterations. Moreover, Geodesignhub makes available tools for effective comparison of the alternative scenarios in form of maps and graphs (Fig. 9), facilitating the participants analyze differences and affinities between the designs.

After the first plan proposal were consolidated through impact assessment iterations, a sociogram for negotiation agreement was created with the aim of finding compatibility, hence possible alliances, between the groups. The sociogram is a matrix where each team vote the syntheses of the other groups, giving them a judgment, from positive to negative, depending on their compatibility with the goals of the team (Fig. 10).

The sociogram clearly showed the teams having higher potential for collaboration. On this basis, two different coalitions of teams were formed (i.e. TOUR, CULTH and RAS, and GREEN and METRO) reaching, after a first stage of negotiation, two combined design solutions (Fig. 11). The DEV group, which initially could not join any coalition for strong actual divergences, during the second stage of negotiation, decided to collaborate with the strongest coalition on the definition of a third negotiated scenario. Lastly, the final Cagliari metro area agreed scenario was reached at the end of a third stage of negotiation among all the teams (Fig. 12). This was the most crucial moment of the workshop, where the discussion not without difficult moments and animated debates, eventually led to the final agreement through negotiation.

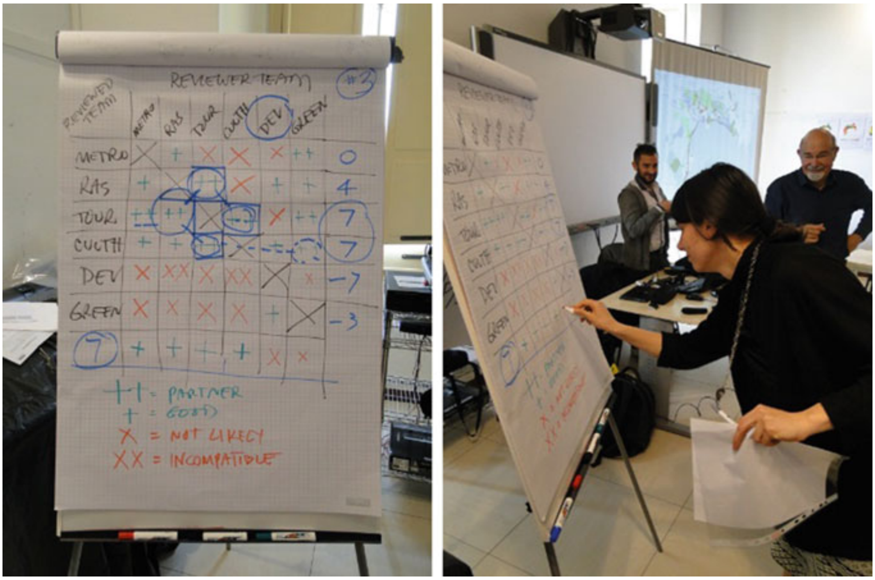

Fig. 10 The sociogram for negotiation agreement

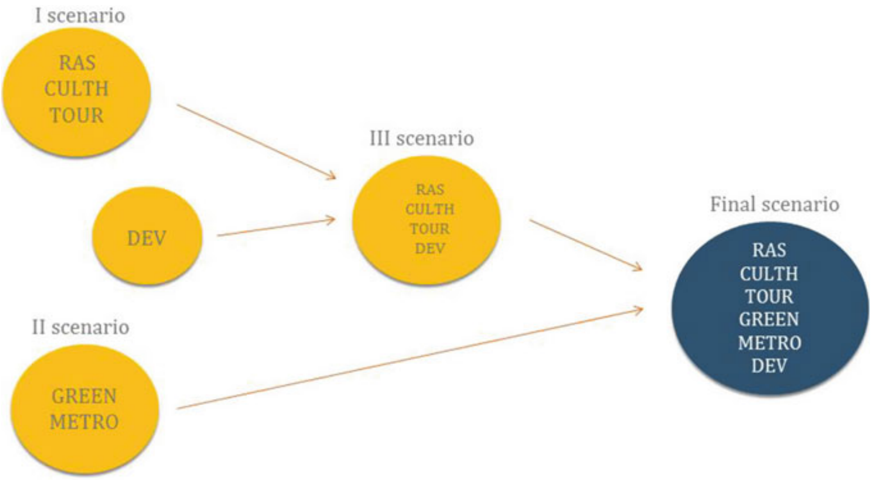

Fig. 11 Re-grouping during the negotiation phase

5 Results and Discussion

Indeed, the workshop represented an opportunity to reflect on the potentiality of the geodesign methodological approach to bring innovation in spatial planning. As a matter of fact, such a dynamic methodology, favored reasoning on the possible

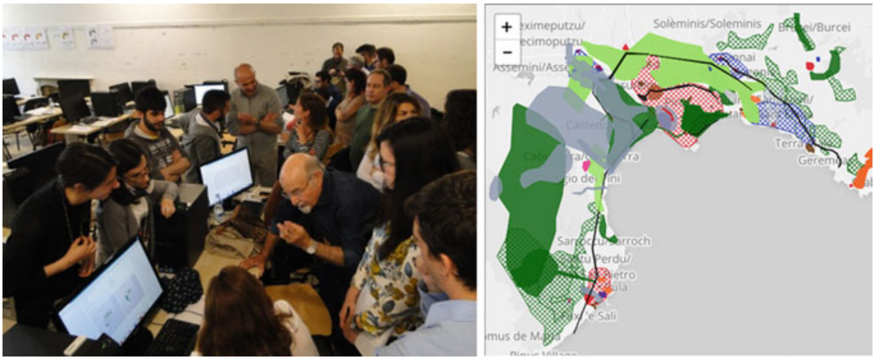

Fig. 12 The negotiation process among the stakeholders and the final agreed design

strategic scenarios for the metropolitan area in a collaborative manner where all the participants could contribute actively, and allowed to attain a conceptual plan of development for the Cagliari metropolitan city after two only days of work.

The analyzed case study confirmed that geodesign might be well applied for the management of a planning process of remarkable complexity, which involves numerous actors and foresees and face the necessity to create and evaluate heterogeneous design alternatives. Thus it appears particularly suitable in the context of the landscape and urban planning process innovation, as introduced by the Directive 2001/42/EC.

6 Conclusions

This chapter presented the application of geodesign methods and techniques to spatial planning. After discussing the innovation of the current planning season introduced by Strategic Environmental Assessment, the authors reported the geodesign study on the future scenario for the metropolitan city of Cagliari (Italy). The chapter focused on the link between knowledge and actions in plan design and decision-making. On the base of the results of the workshop the authors demonstrated how the geodesign approach can support pluralism in design through collaborative decision-making.

Acknowledgements Elisabetta Anna Di Cesare gratefully acknowledges Sardinia Regional Government for the financial support of her Ph.D. scholarship (P.O.R. Sardegna F.S.E. Operational Programme of the Autonomous Region of Sardinia, European Social Fund 2007–2013—Axis IV Human Resources, Objective l.3, Line of Activity l.3.1.).
Chiara Cocco gratefully acknowledges Sardinia Regional Government for the financial support of her Ph.D. scholarship. (P.O.R. Sardegna F.S.E. Operational Program of the Autonomous Region of Sardinia, European Social Fund 2014–2020—Axis III Education and training, Thematic goal 10, Priority of investment 10ii.).

References

Briassoulis H (2002) Sustainable tourism and the question of the commons. Ann Tourism Res 29(4):1065–1085

Brown AL, Thérivel R (2000) Principles to guide the development of strategic environmental assessment methodology. Impact Assess Proj Appraisal 18(3):183–189

Campagna M (2014) The geographic turn in social Media: opportunities for spatial planning and Geodesign. In: Murgante B et al (eds) Computational mscience and its applications–ICCSA 2014. Springer International Publishing, Cham, pp 598–610

Campagna M, Craglia M (2012) The socioeconomic impact of the spatial data infrastructure of Lombardy. Environ Plan B: Plan Des 39(6):1069–1083

Campagna M (2016) Social media geographic information: why social is special when it goes spatial. European handbook of crowdsourced geographic information, pp 45–54

Campagna M, Di Cesare EA (2016) Geodesign: lost in regulations (and in practice). In: Papa R, Fistola R (eds) Smart energy in the smart city. Springer International Publishing, Cham, ISBN 978-3-319-31155-5

De Montis A et al (2014) SEA effectiveness for landscape and master planning: an investigation in Sardinia. Environ Impact Assess Rev 47:1–13

Fischer TB (2003) Strategic environmental assessment in post-modern times. Environ Impact Assess Rev 23(2):155–170

Goodchild MF (2007) Citizens as voluntary sensors: spatial data infrastructure in the world of Web 2.0. Int J Spat Data Infrastruct Res 2:24–32

Leslie E et al (2007) Walkability of local communities: using geographic information systems to objectively assess relevant environmental attributes. Health & place 13(1):111–122

Massa P, Campagna M (2016) Integrating authoritative and volunteered geographic information for spatial planning. European handbook of crowdsourced geographic information, pp 401–418

McHarg IL (1969) Design with nature. American Museum of Natural History, New York

Steinitz C (2012) A framework for geodesign. Changing geography by design. Esri, Redlands

Zoppi C (2012) Governance, pianificazione e valutazione strategica: sviluppo sostenibile e governance nella pianificazione urbanistica. Gangemi Editore spa