Geodesign: (a Personal) Retrospective, and Perspectives

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Abstract. The paper presents a critical retrospective of the author's experiences on the application of the geodesign methodology in spatial planning research, education, and practice. Referring to two main case studies re-iterated along several years in different contexts, the benefits of the approach are highlighted, as well as limitations. The benefits are particularly evident in relation to both the knowledge-building and design process, and the development of skills, capacity building, and innovation of practices, multi-actor collaboration, and consensus building. However, more time will be needed for careful ex-post evaluation which may confirm in the future the quality of the final design products and their implementation, as well as the ability of the involved local communities to support adaptive processes of sustainable transformation of the territory in the medium and long term. The future research directions, therefore, beside covering the monitoring and evaluation of the ex-post impacts of the results of past experiences, should focus on the current challenges of sustainability, and, on the impact of the design on climate change. While early geodesign studies proved effective in integrated strategic spatial planning and design and adaptive planning and governance of urban and territorial systems, integrating the principles and the values of strategic environmental assessment, further research is still needed to understand the applicability of the concept in different contexts with regards to scale, or in the making of traditional planning instruments which still characterize consolidated planning systems, or vice versa, to what extent, geodesign may affect it evolution, and under what circumstances.

Keywords: Geodesign · Adaptive Planning · Strategic Planning · Sustainability · System-thinking · Sustainable Planning

1 Introduction

Current sustainability challenges require urgent actions to contribute at the local level to solving serious global issues that treat the terrestrial ecosystem from the environmental, social, and economic point of view: climate change, migrations, consumption of resources, production of pollutants, population consistency and distribution, geopolitical conflicts, pandemics, are just some of the most serious issues we are currently facing. How do we address these challenges locally? How may spatial planning at the local level contribute to rebalance the global human-environment relationships?

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Policies at European level have been strongly oriented towards environmental, social, and economic sustainability, particularly in recent years when the COVID19 pandemic and the war in Ukraine have further worsen previous, already precarious, socio-economic and environmental conditions. The EU green and digital transitions are, at least in principle, ambitious examples in this direction. However, addressing ecological, social, and economic crises requires the development of strategies and actions to be developed and implemented through collaboration and partnership, although often in conditions of conflicting interests and objectives.

At the local level, there is a need for innovation in order to innovate towards more adaptive forms of spatial planning, that may replace established models which are no longer adequate to respond to global dynamics characterized by complexity and uncertainty, and which have major negative impacts. In this sense, the concept of resilience is changing from an absolute perspective to an evolutionary one, for the construction of which it is necessary in fact to refer to innovative models of adaptive planning (Davoudi, 2021).

In a context, such as Italy, characterized by urban planning regulations based on assumptions now largely outdated, in their inadequacy to promptly react to the current challenges of sustainability, the diffusion of strategic planning and Strategic Environmental Assessment (SEA) have brought elements of innovation in recent decades. Nevertheless, the results of their application are often below expectations. The SEA practices often fail to properly apply its principles and expected outcomes. The potential for knowledge enrichment in spatial planning and decision-making is difficult to appreciate in substantive forms, as SEA often turn out to stay confined within bureaucratic boundaries. The desired construction of design alternatives informed by environmental considerations and savvy use territorial resources promoted by the SEA is difficult to be appreciated in explicit forms in the practice, as well as are explicit responsibility and transparency conditions.

In addition, despite their availability, the adoption of innovative digital tools for planning support is often overly limited in the practice, postponing the future evolution of professionals towards a new paradigm of digital planning (Batty & Yang, 2022), and limiting the potential innovation in supporting communication, collaboration, or quantitative impact assessment, to name but a few of the underlying principles of SEA. Addressing these operational issues would already provide an important contribution to the role of spatial planning with regards to the green and digital transition, and, in general terms, would enable to develop more responsive solutions to sustainable spatial development issues.

The most recent policies on sustainable spatial planning include substantive aspects related to the design (as a noun) of territorial systems such as housing, mobility, health, well-being, safety, consumption, land uses, etc. to be all oriented in the "green" sense, as well as design (as a noun) process requirements related to governance, collaboration, leadership, accessibility, equity, democracy, transparency, participation, digitalization, etc. The question is however still open on how current local practices may combine the two complementary dimensions of design, which are often tied to different disciplinary approaches, in order to achieve, in principle largely agreed, sustainable development

goals. Strategic planning - defined as a transformative process, guided by public initiative but collaborative and open to the community, capable of integrating socio-spatial processes based on shared visions or frameworks of reference, synergistic coherence of the actions and of the means of implementation that define places and their possible futures (Albrechts, 2017)- can provide a more actual and effective approach in this regard. It is with strategic planning, in fact, that a variety of public and private sector actors and stakeholders meet in new institutional contexts to define future development scenarios that integrate interrelated strategies in order to provide a coherent input to the management of changes (Hersperger et al, 2019). Hence, this appears to be the appropriate tier in the spatial governance framework where, perhaps more than in others, the substantive and the procedural dimensions can be integrated into more sustainable spatial planning processes, towards the construction of more equitable development scenarios for the entire local community through collaboration.

2 The Geodesign Approach

In the last decade geodesign gained momentum in academia as an approach able to mediate the accounting of the environmental dimension of planning with collaboration and negotiation, relying on digital computational and communication technologies.

Geodesign can be defined as a set of techniques and enabling technologies for planning built and natural environments in an integrated process, including project conceptualization, analysis, design specification, stakeholder participation and collaboration, simulation, design alternatives creation and impact evaluation (among other stages). Geodesign applies system-thinking and makes the relationships between design and its geographical context explicit, as the design is dynamically related to a multi-scale digital computational twin of territorial systems.

The geodesign methodology approach mainly refers to the framework proposed by Carl Steinitz (2012). If it is true that in the literature other methodological planning and design frameworks may be found, the Steinitz's framework for geodesign is particularly effective in that it is general enough to be applied to a variety of theoretical models and operational contexts in planning, while providing a comprehensive and robust guide for the construction of design processes. The Steinitz framework for geodesign entails - with reference to a set of territorial subsystems (e.g. green and blue infrastructure, transport, residence, cultural heritage, etc.) - the iterative construction of six models: the representation model describes the evolution of the study area from the past to the present (intended either as the starting moment of a geodesign study or last date for which up to date data are available); the process model describes the probable or possible evolution of the territorial system (depending on the considered time span and possible underlying uncertainties) without considering any design change: it represents the do-nothing alternative; the evaluation model defines the possible need for changes with regards to their suitability in space (e.g. evaluation maps); the change model represents possible design alternatives; the impact model simulates the impacts of those alternatives; and lastly the decision model defines the decision-making context. The robustness of the geodesign framework to support the SEA-plan-making process was discussed by Campagna and Di Cesare (2016).

International experiences based on the application of the Steinitz' framework have recently produced effective process and workflows and digital tools to support their implementation, including the so-called "geodesign workshop" which turn out to be particularly robust in strategic spatial planning. *Geodesign workshops* usually take as input the output of the first three models, which constitute the knowledge building base for a geodesign study, and iteratively produces alternative scenarios, and, through collaboration and negotiation, leads to consensus with regard to a final agreed scenario. The explicit link between knowledge and decision is obtained by using the evaluation maps (Campagna et al., 2020a, par. 3): the latter represent a central element of this methodology, an element which is often unfortunately limited or absent in many traditional urban plans. Typically, a *geodesign workshop* applied to strategic planning can produce effective results with the collaborative involvement of several dozens of participants (i.e., community actors) and it can do that in very short time (i.e., equivalent to approximately to two working days). A *geodesign workshop* can be supported by several digital tools, but the one which proved most effective in research, education, and practice is the Geodesignhub web-based planning support system, which, in fact, was designed to implement the geodesign framework (Ballal, 2015) in full-digital settings.

The following section summarizes the main feature of various case studies of implementation of geodesign workshops with Geodesignhub by the author, in research, education, and in the planning practice.

3 Case Studies: (a Personal) Retrospective, and Prospective

In this section, several geodesign studies conducted by the author are described comparatively aiming at identifying successful methodological and operational elements, which may contribute to addressing some of the most pressing challenges inherent in the development of adaptive sustainable strategic spatial planning processes, in the respects outlined in the introduction.

3.1 Retrospective

Starting from 2016 a series of design studies involving geodesign workshop were developed by the author in different areas of Sardinia, at different scales, with different objectives, and in different working contexts. Altogether, these case studies offer useful materials to evaluate the potential of the geodesign approach in planning research, education, and practice (and, in particular, in strategic spatial planning).

The two main study areas were the Metropolitan City of Cagliari (CMC) and the Gulf of Oristano Municipalities (OGMun), where a strategic study on sustainable tourism development was conducted. The study area of the CMC has been the object of several iterations of the study, initially in a research context, then in planning education, and, most notably, in the making of the Strategic Plan of the Metropolitan City of Cagliari, approved thereafter in 2021. Table 1 summarizes the main features of the case studies.

The first CMC case study in 2016 was developed in a research context. In this case the main value in the application of the geodesign methodology was to approach exploratively a new project at an unusual scale, that of the CMC, which had essentially

Table 1. Comparative matrix of geodesign workshops.

Case Study	CMC 2016	CMC 2018	CMC 2017–23	OGMun 2019	CMC 2021
Context	Research	Education	Training	Strategic Tourism Planning	Strategic Planning
Focus	Methodology, design	Methodology, design	Methodology	Design, capacity building	Design, capacity building
Tools	Geodesignhub	Geodesignhub	Geodesignhub, Zoom	Geodesignhub	Geodesignhub, Zoom
Mode	Presence	Presence	Presence/online	Presence	Online
Duration	15 h in 2 days	5 × 3 h in 2 weeks	9 h in one or more sessions	About 16 h in 3 days	4 × 3 h in 2 weeks
Participants	Researchers (30 +)	100 + BSc and MSc Students of Engineering / Architecture	Educators, Researchers (20–40)	5 municipalities (20 + decision-makers and technical staff), enterprises, NGOs	17 Municipalities (30 + Decision-makers and technical staff)

never been previously considered in terms of design by the local scientific, technical, and public administration community. Previous studies had in fact focused on the area of Cagliari and the municipalities of the first ring, which is remarkably smaller than that of the current CMC. The establishment of the CMC in 2016 (LR Nº 2, 2016) with its seventeen municipalities introduced a totally new working scale compared to the context of traditional planning practices in Sardinia, and the case study represented a first exploratory experience to investigate the relevance of territorial phenomena and design scenarios at this new scale. The case study also allowed to test the application of the methodology and to train young researchers, as well as some technical staff from the public administration as well as some freelancers who participated in the project workshop. A research context can be considered very appropriate for a first test as learning exercise for those approaching a geodesign study for the first time, as it was in the case of this authors and many others.

The second iteration of the case study on the CMC has been developed within the education program of the Urban Planning course of the MSc in Civil Engineering, and the Geodesign Course of the BSc in Architecture at the University of Cagliari. More than one hundred students participated to the two studio classes each of which produced a set of scenarios developed by the students collaboratively (Campagna et al., 2020b). In particular, the aim of the project workshops was to assess the impact of the introduction of technological innovations in the territorial project with regards to selected territorial subsystems (e.g., green and blue infrastructure, agriculture, transport, trade

and industry, energy, residence, etc.) in line with the International Geodesign Collaboration assumptions. The learning curve by the students was very positive in relation to both understanding the spatial planning and design approach integrated with system-thinking at the territorial scale and using state-of-the-art digital planning and design tools. The collaborative design methodology, in addition, enriched the design methodologies toolbox of the students, who would normally be trained to design individually, or in small working groups, with an anticipatory approach, typical of large-scale design in architecture and civile engineering.

In the period from 2017 to 2023, moreover, the CMC geodesign study has been used internationally in many geodesign tutorial workshops for educators and researchers in satellite conference events in presence (e.g. Digital Landscape Architecture, DLA, https///www.dla-conference.com/), and online, as part of the International Geodesign Collaboration (IGC) networking activities, or in the training of educators, students, and young researchers during scientific visits to universities in Italy and abroad, or during intensive schools for PhD students. In all these cases, the goal of the application of geodesign intensive tutorial workshops (usually limited to six to nine hours) was the learning of the methodology and of new digital planning and design support tools by the participants.

In the case study of the geodesign workshop for the sustainable strategic tourism development planning in the municipalities of the Gulf of Oristano, which was the first real-world planning practice case dedicated to supporting public administrations and stakeholders of the local community, the main goal of the workshop was to support dialogue and consensus building under conditions of diverse and potentially conflicting spatial development objectives. The workshop was attended by elected representatives and technical staff from the local authorities, as well as by representatives of private enterprises and NGOs. The workshop was held in presence for a total of about sixteen hours divided into two working days. The evaluation by the participants of the application of the geodesign methodology was overall very positive, underlining the fact that the collaborative design activity facilitated communication and constructive dialogue between public administration, enterprises, and NGOs, to a substantially higher level than in the traditional practice. The working methodology allowed to explore new development perspectives for the study area, helping to reach consensus on a shared and coherent development scenario.

Last in order of time, and a most relevant example in terms of complexity both with regards to the territorial dynamics and to the decision-making process, was the geodesign workshop for the Strategic Planning of the CMC. The latter involved the CMC's seventeen municipalities represented both by elected representatives and technical officials. The workshop was a central element in the making of the CMC Strategic Plan, within which process it was developed. With the geodesign workshop, the Municipalities had the opportunity to express their local point of view, both in relation to the wider territorial area and the related wider development objectives of the CMC. The workshop took place in four plenary meetings of three hours each over two weeks, which allowed participants to share their local planning perspectives and integrate it into the wider scenario of the whole CMC area. More than two hundred local projects and policies were collected and integrated in an agreed design scenario during the workshop, for which consensus was

reached through negotiation on four priority levels. The project results of the workshop were incorporated into the final documents of the strategic plan, which was approved in its final version a few months later, in July 2021.

3.2 Prospective

Two new case studies are currently under development aiming at testing new application contexts for geodesign and to assess their effectiveness.

The first case study under development represents a local grass-root planning initiative in the coastal area in Quartu Sant'Elena (Italy). The study area is characterized by a low density coastal residential development, affected by occasional illegal building phenomena, and limited or poor urban infrastructures, in an area of sensitive landscape value. The objective of this project is to involve active citizenship in a geodesign workshop that, starting from the assessment of local issues, expectedly will allow participants to develop an integrated strategic spatial vision for the sustainable development of the wide coastal area, building an agreed development scenario, and, at the same time, building capacities for the local community to improve the dialogue with the local public administration.

The second case study currently under development deals with the whole regional area of Sardinia, and it is a local contribution to an international research project coordinated by the IGC, called the Climate Change Grand Challenge (GC2, https://www-igcollab.hub.arcgis.com/pages/gcgc). The GC2 project has the ambitious goal of exploring planning and design solutions to reduce anthropogenic carbon emissions and protect and strengthen ecosystems and carbon storage. Through a shift of scale between local and global studies, the objective is to study spatial design solutions aimed at obtaining a negative carbon cycle balance in which the amount of carbon emitted into the atmosphere is lower than that sequestered by the territorial system. This base research project ultimately aims to investigate concepts, methods, and tools to develop local designs that may contribute to a global sustainable design.

4 Discussion and Conclusions

The geodesign studies described in synthesis in this paper highlight a flexible geodesign methodology approach that allows to build agile and open spatial planning design processes based on multi-actor collaboration, also thanks to the support of state-of-the-art digital planning support tools with user-friendly interfaces. The variety of actors, with or without technical background, with or without digital skills, more or less accustomed to design practices, coming from different geographical and socio-cultural contexts, which took part in the case studies, shows how technology adapted to methodology, not vice-versa, can effectively support planning, and facilitate fast and effective collaboration and cognitive mediation.

The workflow of the *geodesign workshop* has proved effective in achieving the objectives of the studies, both in research, in education, and in the real-world planning practice; and it enabled to do that in extremely short time. The model is therefore particularly suitable to support adaptive strategic planning where speed, rather than detail, is an added value. Still, the quality of design results and their implementation is to be

further assessed with respect to its application to the planning practice, which in this case may need time. However, the speed of consensus-building by groups of diverse actors is perhaps the most interesting feature as rapid iterations of the same geodesign study can be cyclically repeated with the acquisition of more information and knowledge as territorial conditions change, thus addressing gradually the uncertainty that characterizes many of the most serious current sustainability challenges. This appears to be an important feature, in the transition from traditional to new adaptive processes aimed at addressing the resilience of territorial systems with an evolutionary approach.

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