# Collaborative geodesign: sustainable scenarios for the Cagliari metro area

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**Abstract**

This chapter presents the Metropolitan City of Cagliari sustainable development geodesign study. The study was carried on in 2018 under the umbrella of the International geodesign Collaboration. The aim of this chapter is twofold as it discusses both how strategic scenario planning can unfold in a collaborative way, as well as how technology advances can either support the process and improve the design in addressing current sustainability challenges.

KEYWORDS: geodesign, strategic scenario planning, metropolitan city

## 1. Introduction

Sustainable development is the term commonly and broadly, often generically, used to describe a complex range of principles, and practices aiming at meeting "the needs and aspirations of the present without compromising the ability of future generations to meet their own" (BRUNDTLAND, 1987). The implementation of sustainable development principles requires both technological and social settings should be organized so that anthropogenic activities would not endanger the capability of the ecosystems to absorb their impacts. However, from the general definition to the operational strategies and actions to be implemented at the local level the way is not straightforward. Back in 1992, the Rio Declaration on Environment and Development was adopted by the United Nations introducing 27 principles to achieve sustainable development, and Agenda 21 set the operational framework to implement sustainability principles. While to date, the implementation of those principles and programs still are to be fully achieved, still many Countries around the world are working globally and locally in that direction in many domains, such as, among other, aiming at addressing climate change. In addition, the approach to sustainability since the early stages continued to evolve introducing further tools to help communities around the world to reach the objective, including the UN

Agenda 2030's Sustainable Development Goals (SDG), which represents a way to transpose global principles into operational objectives, globally and locally.

Indeed sustainable development is a complex and multifaceted concept, and this is possibly why its holistic implementation is far to be fully achieved to date. It concerns the complex relationships between humans and the environment and it requires both the wise management of natural resources as well as the reduction of pollution originating from human activities. Though it also pertains social aspects such as balanced distribution of wealth and the broader democratic participation in decision-making. In this respect, the contribution of science and technology is seen as necessary support for informed decision-making.

When it comes to spatial planning and design traditional approaches seems to be limited in addressing the complexity of current challenges. Innovation is required both with regards to actions of physical transformation as well as to the processes we organise to plan and implement them. However, innovation may requires a substantial paradigm shift which is often not easy to achieve. Good principles, even when they are broadly adopted, often need time to be fully implemented by a practice in evolution. In Europe, as well as in many other Countries worldwide, environmental protection has since decades been acknowledged as a priority of utmost importance, nevertheless this common goal is far to be achieved. In our current days in Europe, at the time of the COVID19 pandemic the *green new deal* and digitalization start to be seen as major strategies to address urgent environmental challenges as well as an opportunity for revitalizing an economy affected by profound crisis. However, it should not be forgotten that earlier attempts of introducing innovation towards environmental protection still somehow failed to fulfil their objectives, and further efforts should be indeed put into place. More specifically, Environmental Impact Assessment and Strategic Environmental Assessment where firstly introduced in Europe by Directive 85/337/EEC and by Directive 2001/42/EC, respectively, as innovative measures to avoid projects and plans were adopted without a precautionary assessment of their possible negative impacts on the environment would be carefully assessed (and considered acceptable) in the face of the expected benefits. These regulations transposed many sustainability principles, including protecting natural and cultural resources, ensuring transparent and informed decision-making as well as fostering inclusive participation of stake-holders, and to a certain extent, of the broader local communities. Nevertheless the implementation of the innovation put forward by the Directives is still far to be achieved. This is not necessarily due to lack of political will or of poor performance in institutional settings, but often also by

a frequent lack of suitable methods and tools in planning and design. In this sense, while the Directives in principle require to change the process through which projects and plans are made, and EIA and SEA should be seen as an enrichment of design and plan-making, in reality frequently these are parallel processes, or even serial in worst cases. Extensive surveys carried on in the last decade by the European Commission shows that EIA and SEA frequently fail to fulfil their substantive requirements, including developing project/plan alternatives, robust impact assessment, transparency and accountability, to name few. A sound EIA/SEA process indeed would require a paradigm shift in design and plan-making which is often still poorly understood by many professionals and practitioners. Recent research in geodesign (CAMPAGNA, DI CESARE, 2016), contributed to shed light on how the normative and technical settings should be enhanced to effectively respond to the current urgent call for innovation. From the methodology point of view, recent advances in geodesign research may offer reliable tools to bring innovation into the planning and design practice, making value of the digital spatial data resources made accessible by the growing Infrastructure for Spatial Information in Europe (INSPIRE, Directive 2007/02/EC).

In the light of the above premises, this chapter introduce the geodesign approach as a way to bring innovation in spatial planning aiming at fulfilling more sustainable processes and planning and design products.

## 2. Geodesign: grounded in the past, oriented towards future

Geodesign is a methodology approach to spatial planning and design which aims at bridging the gap between geography and design, or more operationally to change geography by design. As such geodesign has old roots grounded in the tradition of architecture, urban and regional planning, landscape architecture and planning trough the work of pioneers such as Howard and Geddes, Wright and Neutra, Olmsted and Manning, Lynch and McHarg, to name few. It is due however mostly to the work of Carl Steinitz the contemporary view of geodesign which couples in his framework for geodesign (STEINITZ, 2012) the environmental planning approach – the McHargh's idea of design with nature - to collaboration and negotiation in spatial decision-making with the support of state of the art digital technology, which characterise the current geodesign approach. The role of technology is not a merely instrumental quantitative value, for it allows the creation of multi-scale interactive computational environment (or digital twins) which if properly used may produce substantial quality

improvement in the planning and design process and in its results contributing to address some of the most urgent challenges of our time. In fact, while geodesign can eventually using traditional media, technology enables and boosts data integration and analysis, simulation of territorial dynamics, real-time interactive alternative collaborative design, real-time impact assessment, effective negotiation. As such, not only the real-time impact assessment of design alternatives enable their interactive improvement, but the alternatives are actually created iteratively based on environmental considerations, which is one of the most crucial and less understood and practiced step in the SEA compliant plan-making.

## 3. The role of technology in geodesign

While geodesign make extensive use of state-of-the-art digital technologies to support the process (i.e. geodesign as a verb, STEINITZ, 2012), technology innovation is also seen as an important component of project (i.e. geodesign as a noun, Steinitz, ibidem) intended and able to address current challenges. This dual technology innovation perspective may be grounded in the principle that urban (or territorial) systems evolve along asymptotically towards a point of failure (WEST, 2017), and to avoid its crisis innovation is actually needed. Along a similar line of thought, in 2021 the Bertrand Piccard's Solar Impulse Foundation, has officially passed the mark of 1000+ identified solutions to protect the environment in a financially profitable way. Geodesign research has also recently addressed the question of how technology innovation may improve the quality of spatial planning and design in order to address current sustainability challenges thanks to the work of the International Geodesign Collaboration (IGC, https://www.igc-geodesign.org/) a global network of about 250 (mostly) academic partners aiming at promoting the geodesign approach within academia to train future professionals to handle current sustainability urgent issues (Fisher et al, 2020). Similar issues, though with a more general research perspective, is also the main focus of the thematic group New Technologies and Planning of the Association of European Schools of Planning (AESOP, http://www.aesop-planning.eu/blogs/en_GB/new-technologies-planning). The model in Figure 1, synthesises this dual vision.

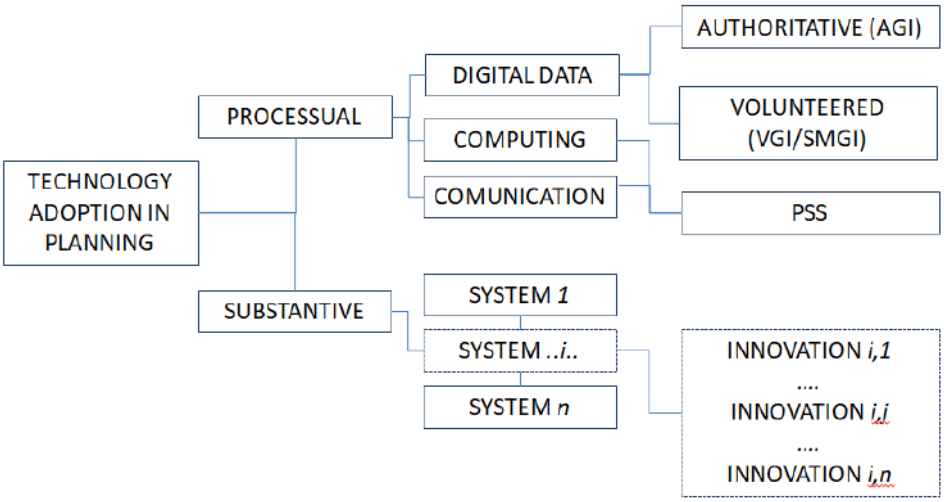


Fig. 1–New technologies in planning

From the process perspective, while being not necessarily needed for its successful application, geodesign makes the most value when relying on recent advance in technology both in procedural and substantial form. Recent developments in spatial and temporal Information and Communication Technology offers unprecedented potential in supporting the planning process in all of the common design tasks including representation, analysis, forecasting, and assessment. The diffusion of geographic data involves authoritative and volunteered geographic information sources. In Europe, Directive 2007/02/EC established the INfrastructure for SPatial InfoRmation in Europe (INSPIRE) offers seamless open access geographic information concerning most needed spatial data themes. In addition, the developments and the diffusion of geographic Internet technologies, such as geo-browsers, enabled the rising of neo-geography (Haklay et al, 2008). In the last decade or so, the research on Volunteered Geographic Information (VGI) and Social Media Geographic Information (SMGI) bloomed, demonstrating unprecedented capabilities in monitoring not only the physical environment but also social behaviours and dynamics (CAMPAGNA, 2016) in real-time.

Computing power has dramatically increased as well in the last decade, pushing gegraphic data processing and visualization to an unprecedented level. Software development faced constant advances, up to extending Geographic Information Systems (GIS) in fully and seamlessly supporting planning and design tasks thanks to the diffusion of Planning Support Systems (PSS).

Nevertheless, bottlenecks where often found in limiting the widespread diffusion of PSS in the planning practice, and among them the lack of sound theory (or methods) behind was possibly one of the most relevant. This issue was actually addressed in the design of the GeodesignHub web PSS (BALLAL, 2015). In his PhD thesis at University College London, Ballal designed a PSS focusing on the process relying of state of the art open-source geographic web technologies and basing the structure of the workflow on the Steinitz' framework for geodesign (STEINITZ, 2012).

In the next section, the geodesign study on future scenarios of the metropolitan city of Cagliari is presented as example implementing the approach.

## 4. Future scenarios for the Metropolitan City of Cagliari: a geodesign study

While the author carried on several iteration of the Metropolitan City of Cagliari between 2016 and 2021, both in research, teaching, and real-world planning settings, the case study presented in this section was conducted in 2018 in order to apply the IGC approach. The presentation of the case study is reported aiming at highlighting how the process (and the adopted technology) enabled the collaboration of dozens of participants, who in the limit of a 15 hours long workshop developed alternative planning scenarios in a collaborative way. Similar results have been successfully obtained with the same approach, although with slightly difference settings, in the geodesign workshop conducted in 2021 within the making of the strategic plan for the metropolitan city.

Geodesign applies system thinking so allowing to consider a study area in a comprehensive way. The study was built applying the Steinitz's framework (2012) for geodesign. Professional GIS software and the Geodesignhub web-based PSS were used to prepare and conduct the workshop respectively. The workshop preparation consisted of the understanding of past, current and future territorial dynamics in the area with regards to selected systems including green and blue infrastructures, agriculture, industry, commerce and energy, transport, lower and mix-higher-density housing, institutional services (i.e. IGC standard systems) plus cultural heritage as relevant system in the study area. An evaluation model was built for the 10 systems at hand Figure 2), which as output produced 10 evaluation maps. Each evaluation maps classifies in five categories the suitability for changes for one of the systems, identifying areas where: 1) actions are not needed because the system is already working well; 2) actions are not feasible; or

3-5) actions are increasingly feasible, suitable, or very suitable. As such the knowledge building part of the process assisted by GIS, which is nevertheless iterative in implementing the representation, process and evaluation model of the framework is summarise in the 10 maps as input for the creation of planning alternatives, for impact assessment and for decision-making is summarised in a set of color-coded digital maps.

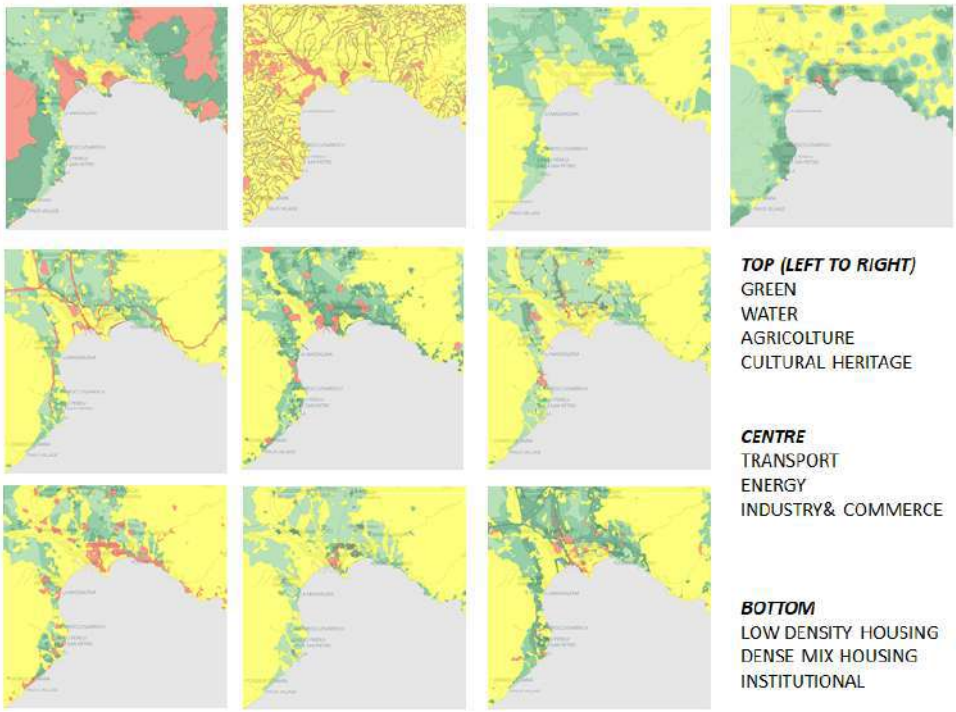


Fig.2 –Evaluation maps for the 10 systems in the Cagliari IGC 2018 study

Based on evaluation maps' input, in the first phase of the workshop more than fifty participants proposed and shared with others individual diagrams representing project and policies in a sort of bottom-up design crowdsourcing. This is the first step where collaboration happen as each participant is able to propose and to communicate to others ideas for change based on system suitability. All the diagrams proposed by the participants are "collective property", to be used by design teams in the following phase (Figure 3).

Fig.3 – Examples (excerpt) of design diagrams matrix. Diagrams representing projects and policies are arranged by system and color-coded. The matrix usual includes several dozens of diagrams.

In the second phase of the workshop, the individual participants join a design team. Each team have its own individual set of objectives, which can be based on actual needs and interest which may be competing or conflicting with others as it mostly happen in the practice, or on different time horizons and degree of technology innovation as it is the case with the IGC format.

Based on that, each teams explore the diagrams and select those which fulfil their objectives or scenario requirements depending on the workshop settings. This way complex integrated design alternatives, or syntheses, are generated, and iteratively assessed in terms of impacts, and improved. In the final phase of the workshop, alternative syntheses are compared, and mediated through negotiation among teams, until a final synthesis is reached based on consensus.

In the Cagliari IGC 2018 workshop in particular design teams were required to develop different scenarios for 2035 and 2050, acting as Early Adopters (i.e. technology innovation is adopted in the 2035 scenario), Late Adopters (i.e. technology innovation is adopted after 2035 in the 2050 scenario), Non-Adopters (i.e. no technology innovation 2050).

Figure 4 proposes the final scenarios of the Cagliari IGC 2018 study.

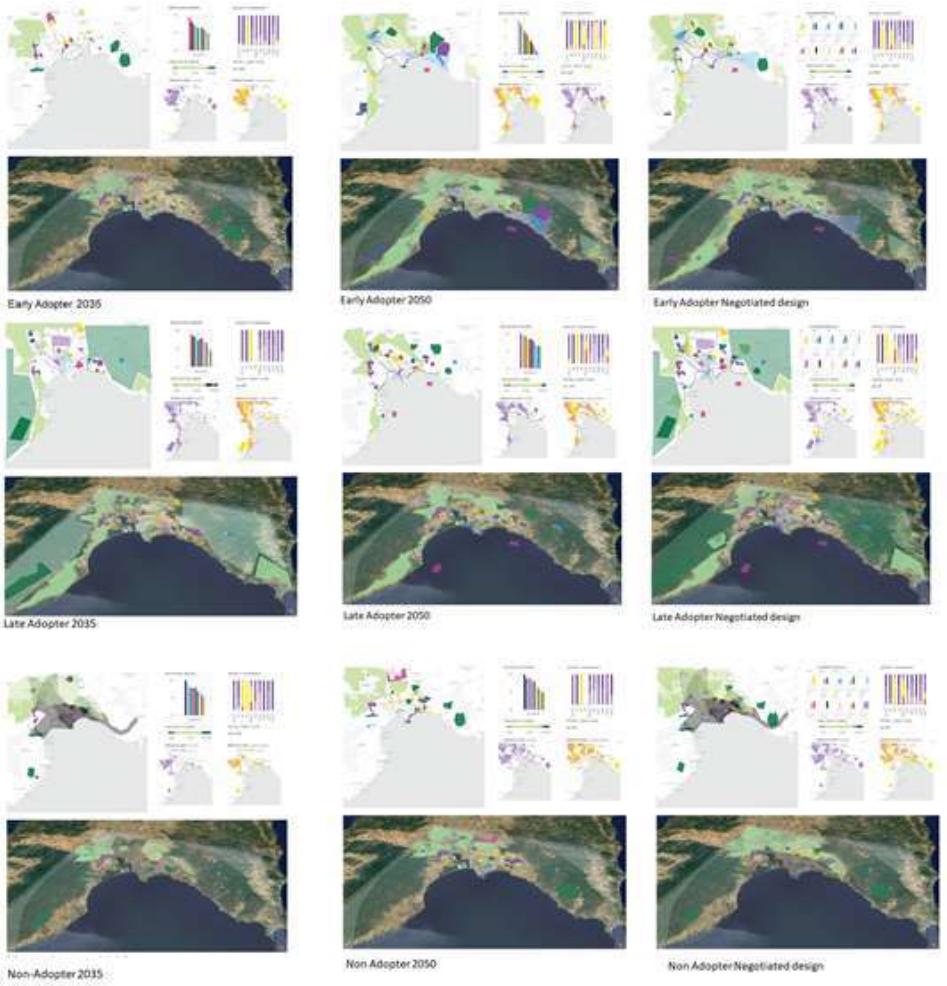


Fig.4 – Each frame shows a scenario in 2D and 3D, the team decision-model, and the impacts. The right column proposes the negotiated design for each technology innovation scenario requirements (i.e. EA, LA, NA)

## 5. Discussion and conclusions

The case study briefly reported in section 4 streamline the geodesign workshop workflows in its main phases. As it is shown, the final design is obtained with the collaborative contribution of all the participants who propose individual projects and policies, integrate them in complex comprehensive syntheses, and mediate alternative scenarios through negotiation toward

consensus. The approach may be applied in a variety of settings depending on the local context and objective of the design study for research and education purposes (as in this example), as well as in real-world strategic planning processes. The evaluation maps represent in an explicit way locational system opportunities and constraints scoping and guiding design alternatives, which are then subject to impact assessment iteratively. Negotiation help to mediate solutions for different, competing, often conflicting interests of the involved parties.

The process is fast if compared to other methods especially in real-world planning process, and it does not requires any technical skills, resulting accessible to any kind of social actor. A number of case studies are available in literature documenting the involvement of school-children, elder people, or other social groups which usually are not able to join a planning process either for institutional or socio-technical issues.

In addition, beside reaching agreement and consensus very fast, the process results as enriching experience for the participant. In the case study, a class of more than fifty civil engineering students with little or no previous knowledge of planning and of geographic information technologies completed their tasks in five 3-hours sessions only, showing as surprisingly fast learning curve both in planning and design, and in using state-of-the-art digital technology. As such the geodesign approach is very promising both in research and education for future planners which are likely to be challenged by urgent and unprecedented global and local sustainable development issues, as well as in the real world planning practice, where traditional methods often shows failures in their capacity to address our current complex and urgent challenges.

In summary, the current geodesign experiences were successful in:

- Making value of digital data sources and supporting digital technology;
- Supporting informed collaborative decision-making;
- Enabling the participation of actors which traditionally have limited opportunities for participation;
- Making the process transparent;
- Improving the understanding of complex territorial dynamics and proposing integrated solutions thanks to system-thinking;
- Finding rapidly solutions based on consensus;
- Exploring the potential for technology innovation in the design.

Geodesign research and practice, in its current meaning, in a sense is still in its infancy but it is attracting fast growing widespread interest of scholars, educators, and practitioners. More efforts are needed to test and apply the approach but early results are definitely promising.

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