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# Innovation in Urban and Regional Planning

Proceedings of the 11th INPUT  
Conference—Volume 1

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Editors

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*Editors*

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# Preface

The 11th Edition of the International Conference focuses on how to integrate nature-based solutions in urban and regional planning processes and science. Previously planned for September 2020, due to the COVID-19 pandemic the INPUT 2020 Conference will be hosted in 8–10 September 2021 by the University of Catania (Italy).

The overarching theme of INPUT 2021 edition is “Integrating Nature-Based Solutions in Planning Science and Practice”. There is growing evidence that nature-based solutions (NBS) are strategic instruments to restore or improve the functionality of urban ecosystems towards more livable, healthier and resilient cities. Despite their many advantages, NBS are not widely implemented because the evidence of their effectiveness is not yet sufficiently diffused among policy-makers, city-planners and residents and because NBS are often overlooked due to the complexity of their design and lack of normative instruments supporting planning choices. In order to permanently incorporate NBS into planning instruments, more research and international discussion are required to consolidate the fragmented evidence that NBS can significantly improve the overall degree of environmental sustainability of contemporary cities.

INPUT 2020 gathers international scholars in the fields of planning, civil engineering and architecture, ecology and social science, to build and consolidate the knowledge and evidence on NBS and to help an efficient implementation and replication of solutions.

The INPUT 2020 Conference hosts 14 thematic sessions, namely:

- Enhancing the use of nature-based solutions in urban planning
- Modelling to innovate planning solutions for socio-ecological systems
- Input visions: new technologies, data and hybrid models for spatial planning
- Urban metabolism and simulation for decision-making in spatial planning
- Performance-based planning
- Computational planning
- Geodesign for informed collaborative spatial decision-making

- Planning and design of ecosystems services: assessment frameworks, models, mapping and implications
- Green infrastructure for planning healthy urban environments
- The mitigation of peripheralization risk in urban and regional planning
- Strategies and actions for climate change adaptation and mitigation in mediterranean regions
- Analysis and planning of rural landscapes
- Accessibility in urban planning: moving towards innovative approaches
- Maintenance, upgrading and innovation in cultural heritage

This book presents the first collection of 69 contributions submitted to the INPUT 2020 Conference, following the first call for paper launched in Winter 2020. The accepted articles, after a blind-review process, are here organized in 5 topical parts, which group together the 14 thematic sessions of the conference:

- Nature and Ecosystems for Urban Systems
- Models and Technologies for Spatial Planning
- Climate Change and Spatial Planning
- Peripheries, Rural and Cultural Landscapes
- Accessibility in Urban Planning

INPUT 2020 proceedings explores empirical as well as theoretical frameworks for NBS, their attitude to provide ecosystem services, to deal with climate change effects and to support mitigation and adaptation planning strategies. Integration of NBS in planning science and practice is investigated across different contexts and scales, from urban cores to peripheries as well as from rural to cultural landscapes. Above all, this collection presents the state of the art of modelling approaches and innovations employed in urban and spatial planning, with a trans-disciplinary, boundary-less character to face the complexity of contemporary socio-ecological systems and following a practice-oriented approach aimed to problem solving.

INPUT is a group of Italian academic researchers and academics working in different fields related to the exploitation of innovation for urban and regional planning, with particular reference to geo-informatics and socio-ecological aspects of spatial planning. INPUT Conference is held every two years in Italy, with last editions been hosted in Viterbo (2018), Torino (2016), Cagliari (2014) and Potenza (2012).

INPUT 2020 Conference is organized by [LAPTA](#), a research laboratory of Department of Civil Engineering and Architecture of the University of Catania (Italy), working on sustainable urban and landscape planning.

Catania, Italy  
December 2020

Daniele La Rosa  
Riccardo Privitera

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# Co-creation of Ideas in Geodesign Process to Support Opinion and Decision Making: Case Study of a Slum in Minas Gerais, Brazil



Ana Clara Mourão Moura  and Christian Rezende Freitas 

**Abstract** Geodesign is a method that deals with the potential of geoinformation technologies on shared platforms to create collective agreements, by processes of co-creating ideas for the territory. The case study demonstrates the potential of a web-based platform developed by the authors for Geodesign processes, adapted to the local culture, with exploration of data consumption resources and adoption of mechanisms for collective creation of ideas and of voting based on the Delphi method. The case study reports a work developed in a slum called Confisco, located in the cities of Belo Horizonte and Contagem, Minas Gerais, Brazil, where people live under pressure of social and environmental risks. The platform developed was initially tested with a group of academics from the university, with the goal to defining adjustments on geovisualization of information, but the main application was with people of the place. We emphasize that the platform favors the understanding of the citizen's reading ability about their reality, reducing external interference in the process. As a result, we observed the importance of the mediators of the technical staff, who act as a support for understanding the dynamics of the process, but respecting citizens' participation.

**Keywords** Spatial inequalities · Framework · Participatory planning

## 1 Introduction

Geoinformation technologies are undergoing a significant change in paradigm related to the use and production of georeferenced data and information, as it is intended for adaptation to the end user. In this sense, it is largely based on

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geovisualization and accessed by the world wide web, as its main purpose is to support the construction of opinions and decision making. The user of geoprocessing has increasingly migrated to web-based platforms, supported by institutional incentive (through the role of SDIs), by the increased interest of stakeholders in consumption information, and also by the technicians' understanding of their role as decoders of collective will in territorial planning actions.

According to UN-Habitat studies, in 2005 the population living in towns and slums in Brazil corresponded to 25% of the inhabitants of urban areas, what means that from about 160 million inhabitants in urban areas, 40 million people live in areas of social fragility (Farias et al. 2017). In 2010 IBGE presented the numbers for the main cities in Brazil, comprising 6329 "subnormal units" where around 11 million people live. Slums or subnormal units are areas of social fragility, but in addition to them there are also irregular settlements characterized by lack of infrastructure and non-ownership of land, a group that is also numerous, estimated by IBGE in 6 million people.

Urban regulations guarantee the right to housing and local plans need to create mechanisms to collectively discuss the futures for these areas in inclusive planning (Fernandes 2002). The principle of planning with different actors in society, when based on geoinformation technologies, has already been characterized as Critical GIS (Elwood 2006). It was also defined as "Participatory GIS", "Collaborative GIS", "Community Integrated GIS" whose objective was to promote public participation in territorial policies using platforms containing geographic information, and some of them to collect and make available information created collaboratively by citizens (Sieber 2006; Balram and Dragicevic 2006; Elmes et al. 2004). Participatory Planning has also been proposed through Geodesign, which means to design "with" and "for" the geography, including different actors to discuss alternative futures (Dangermond 2009; Ervin 2011; Flaxman 2010; Steinitz 2012; Miller 2012).

The Geodesign process, therefore, when incorporated with the fundamentals of SDI (Spatial Data Infrastructure) and Web-GIS can be a robust support structure for the creation of opinions and decision-making through participatory planning and making full use of the resources of geoinformation technology. It is from this principle that this paper presents Brazilian Geodesign platform—supported by SDI and Web-GIS—as a methodological process and technological support for the co-creation of ideas and citizen participation, through the case study of an area of social fragility in Belo Horizonte, Minas Gerais, Brazil.

The city of Belo Horizonte has 2.5 million inhabitants, 13% of whom live in 286 slums or 29 irregular settlements (Monteiro et al. 2018). The case study is in the Confisco irregular settlement, which started in 1988; today there are about 4500 people living in an area of 36 ha (Fig. 1). The area has some infrastructure, but to plan their future it is important to discuss about potentials for densification and uses, basic services, leisure, environment and quality of life, protection of risk areas and legal restrictions on occupation, accessibility, transport, among others. It has as a great challenge the need for land tenure regularization of part of the lots, and the fact that it is between two municipalities: Belo Horizonte and Contagem. The



**Fig. 1** Confisco in 1988 and in 2019. *Source* Photography 1988—from Facebook of local community, and 3D representation from drone capture, Geoprocessing Laboratory, EA-UFMG

community is organized and has an association that fights for their rights, which makes them able to take part in a participatory planning meeting.

In 2019 the Geoprocessing Laboratory of the EA-UFMG was invited to collaborate on Geoprocessing and Geodesign in the Confisco case study, a project that was under development by the group of Interact-Bio project, a partnership between UFMG, Belo Horizonte City Hall and Contagem City Hall. In the first year we used the Geodesignhub platform (Geodesignhub 2020; Ballal 2015) but from the analysis of the results, in 2020 we decided to test the Brazilian Platform, which presents a methodological workflow and a set of its own facilities, resulting from the evaluations of many workshops developed by Geoprocessing Laboratory. It was the product of the PhD thesis by Freitas (2020).

## 2 The Brazilian Geodesign Platform, Based on SDI and Web-GIS Resources

The Brazilian Geodesign platform explores the principles of PSS (Planning Support System), as it works by defining actors, tasks, products to be achieved. It integrates the facilities of SDI and Web-GIS, allowing that participants to receive the information prepared for the workshop, but it can add new layers through connection with other platforms (via Web Map Service, WMS) or by consulting the metadata catalog. The framework is not rigid and can be adapted to the specific needs of each case study. It is a web-based platform that relies on geovisualization, with the intention that the user makes intuitive use of information and participates in the collective construction of proposals.

To structure a Geodesign workshop, it is necessary to identify the main characteristics of the area, according to vulnerabilities and potentialities. The organizer should prepare a robust collection of data about the area and present it with good geovisualization treatment. In addition to data layers and their organizations in the contexts, a drone capture was carried out, to develop a product in 4 dimensions (for virtual navigation) to make easier for the participants to understand the area.

Data were organized according to contexts defined by the organizer. A context should be understood as fundamental issues or values that are intended to be discussed in the workshop, whereas layers are the main component variables that help to understand these contexts. In the case study the contexts were environment, housing, and daily life. In “Environment” context the goal was to propose areas to protect and to improve local thermal comfort in densified ones, to plan requalification of the landscape and to propose interventions in risk areas. In the context “Housing” the goal was to plan new areas for this use and possibilities of densifying in existing ones, as well as where it would eventually be indicated to remove existing buildings due to some risks. In the context “Daily life” the goal was to discuss the basic needs related to public services, infrastructure, facilities, commerce, and activities of interest in the area.

The organizing group must define the composition of the actors who will participate, that must be representative of society’s groups or society’s thoughts. In Confisco case study participants were composed of people of the place (1/3 of the participants), public administration from Belo Horizonte and Contagem (1/3 of the participants) and academics (1/3 participants). The workshop took place during the period of social isolation due to the pandemic of Covid-19, and because of that it was 100% remotely and by videoconference, what made the inclusion of people of the place even more challenging. To make possible for the people of the place to participate, there was a support of a facilitator who worked with them using WhatsApp to exchange information, collect opinions and share the computer screen, since they didn’t have computers and had limited access to internet.

### 3 The Framework and Steps in the Confiscation Workshop

The platform can be used according to different frameworks, as optimal paths defining actors, activities, moments of integration, partial stages, and final stages. For the studies developed so far, we followed a framework based on 4 steps, namely: enriching the reading experience, proposition of ideas through dialogues, debate on ideas also through dialogues, voting and vote statistics to reach the final decision (Fig. 2).



Fig. 2 The framework applied. *Source* The authors

### 3.1 Step 1: Enriching the Reading Experience

Step 1 has the goal to provide a robust collection of data, organized according to contexts of interest. Instead of working with segmented variables, data is organized as collections of variables that together characterize a context, an axis of discussion. To inform themselves about the characteristics of the case study, participants work per context, analyzing the layers of variables, applying transparencies, changing the overlapping positions. Participants can add data from other sources using the metadata catalog or connecting to other platforms by WMS. In addition to being informed by existing data, participants must act actively inserting annotation points complementing data.

The annotations result in Volunteered Geographic Information (VGI) composed by georeferenced points, symbolized according to an agreed legend per themes. In the notes, the participant inserts suggestions, doubts, or additional information that she or he deems important for others to know (Fig. 3). The step is called enriching the reading experience, since the user consumes and provides information, expanding the understanding of the case study. It is a way to minimize possible failures or absence of data, an issue that is often a reason for complaints from participants.

### 3.2 Step 2: Dialogues—Generating Ideas

From reading the entire collection of data (those provided and those added by the participants) the participant draws polygons representing ideas by context. They are oriented to give detailed information about the proposal, including a quality description of it.

Polygons are associated with the names of their authors, as a metadata table is produced, but the coordinator can decide for the use of a generic name, or a general name per group of participants. The intention to register authorship of the proposals is justified for the case the platform is used in institutional public processes in which the steps must be informed in a protocol, registering responsibilities and representativeness.



Fig. 3 Standardization of annotations captions and examples of different themes

### 3.3 Step 3: Dialogues—Discussing Ideas

Once the polygons of ideas have been designed, participants are invited to analyze all the proposals and make comments they deem necessary. It is not mandatory for them to comment on all ideas, but we observed that most participants decided to comment on all proposals. These comments may include justified disapproval, technical questioning, information complementation, questions to be answered by the proposer of the idea, suggestions for adjustments, encouraging the adoption of the idea, among others: a debate among the participants (Fig. 4).

The order in which the participants contact the ideas takes place in the form of a cycle. Participants are classified according to groups of interest, so that the group of participants that register first their opinions in a context are those who understand the most about the subject. Those that come in sequence can read what the experts have already said, what influences their thoughts, what follows the logic of Delphi method.

The cycle was organized so that the Academic group was the first to discuss the “Environment” context, after that they discussed “Daily Life” context and finally the “Housing” context. The Public Administration group was the first to discuss the “Housing” context, then discussed “Environment” context and finally the “Daily Life” one. Local people first discussed the “Daily Life” context, then discussed “Housing” and finally “Environment” (Fig. 5).

### 3.4 Step 4: Voting and Statistics to Decision Making

After all comments and discussions have been registered, each participant is individually invited to vote on each proposal. For this, they read all the comments and decides on the vote. A participant who was already sure about his position of

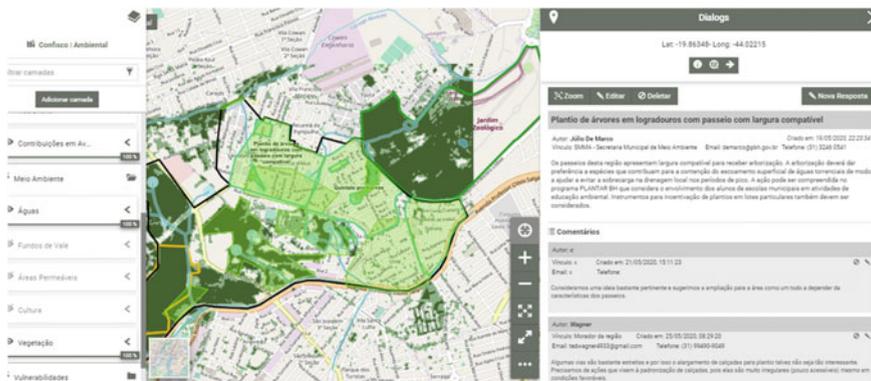
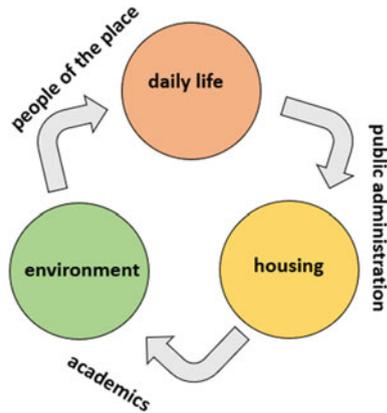


Fig. 4 Comments and brainstorming in the form of dialogues

**Fig. 5** Working on cycle.

Source The authors



approving or not an idea would not change his opinion, but the one who had any doubts, when reading all the comments, tends to follow the majority. This form of voting also follows the Delphi principle, to favors consensus maximization and to avoid outliers.

It is noteworthy that the vote is individual. Participants can work in groups, listening to different thoughts, but it is essential that they position themselves individually, avoiding the “herd effect”. They vote individually freely, as the vote is not identified.

Once the first round of votes is carried out, an algorithm developed by Extract, Transform and Load (ETL) functionalities is applied, which is a script that computes the votes and separates the polygons from ideas according to the percentages of cut ranges defined by the coordinator, that in the case study were from 0 to 30% for disapproved ideas, above 70% for approved ideas, and from 30 to 70% the ideas that should be reviewed.

Depending on the decision of the coordinator, the ideas that remain “in between” approved and not approved can be put up for discussion and vote again, as the participants can defend adjustments to make their proposals successful. There are different ways of conducting a vote at this stage, that can, for example, the inclusion of new comments and new voting section to the ideas under analysis (Fig. 6).



**Fig. 6** Ideas approved, to be discussed, not approved

## 4 Results and Discussions

The Brazilian Geodesign platform was designed based on the many experiences carried out on other international platforms or applications (Geodesignhub, ArcGis, Community Viz, City Engine, analog processes) and aimed to act on some weaknesses in the processes that always appeared as problems in the previous workshops:

- Instead of presenting a reductionist synthesis of a single map that already indicates where the participants should draw their proposals, being based on SDI, favors that each participant visually builds his synthesis and opinion, from the free use of robust data collection;
- The topics for discussion are not worked in the form of systems, but of contexts. Contexts are values or sets of issues that need to be discussed in a case study. That is, instead of thinking about needs and potentialities in a segmented way, one thinks of contexts or values to be achieved, and in these contexts, there are different variables or systems to be considered. To work like this, the coordinator sets up the contexts and decides which variables will be present as information, and the same variable or system may happen to be in more than one context.
- Discussions can be collective, in groups, but the votes are individual, giving the right to speak to each one and avoiding the processes of conducting opinions. Individual votes, in turn, are much better supported by a collection of comments, allowing the participant to decide not only on the location and name of the idea, but on a set of additional information shared and built collectively. The factor of working in the form of cycle favors that the most specialists register their comments first, helping to understand the problem.

Regarding the outcome of the workshop itself, as well as the great challenge of carrying it out entirely by videoconference and having socially vulnerable people as participants, some reflections are appropriate. The big challenge was the participation of people from the call, as it was difficult to identify people who were volunteers, who knew the area well and who had internet and computer at home. If the COVID-19 pandemic had not prevented the face-to-face meetings, it would have been easier to take some notebooks to Confisco area and conduct the meeting using these devices.

What we observed was that most people in socially fragile areas have cell phones with access to an internet package, and this is the main digital instrument they have, but the vast majority do not have a computer and have no internet provider at home. The organizing group had to mediate the participation of these people through the equipment they had: the cell phone and WhatsApp. Then a mediator was responsible for making a call together with them and sharing the image of the computer screen, explaining the maps, and asking questions about where to draw proposals and about their opinions on each idea. The mediator took

notes, drew the ideas, and wrote the comments on the ideas based on their requests, and similarly captured and recorded the individual votes of the participants. It was the way they found themselves to make the debate through the only equipment they had in the period of social distancing.

At the end, a questionnaire was applied to the participants so that they scored the difficulties encountered, and we recognize that many of them were from people of the place, and could have been easily circumvented if the workshop had not been 100% at a distance. On the other hand, it was a different and challenging experience that faced the new requirements of new life in cities during and after Covid-19 pandemic, proving that, although more difficult, it is possible to do a 100% online workshop. The great majority of the participants registered that the experience was generally positive, and that the platform can be more widely used in participatory planning processes, through co-creation and geo-collaboration.

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## References

- Ballal H (2015) Collaborative planning with digital design synthesis. Doctoral Dissertation. University College London
- Balram S, Dragicevic S (2006) Collaborative geographic information systems: origins, boundaries, and structure. Idea Group Publishing
- Dangermond J (2009) GIS: designing our future. ArcNews, summer 2009
- Elmes G, Dougherty M, Challig H, Karigomba W, Mccusker B, Weiner D, Fisher P (2004) Local knowledge doesn't grow on trees. In: Fisher PF (ed) Advances in spatial data handling. Springer, Berlin, pp 29–40
- Elwood SA (2006) Beyond cooptation or resistance: urban spatial politics, community organizations, and GIS-based spatial narratives. *Ann Assoc Am Geogr* 96(2):323–341
- Ervin S (2011) A system for Geodesign. DLA Keynote. Abstract, pp 158–167
- Farias AR, Mingoti R, Valle LB, Spadotto CA, Lovisi Filho E (2017) Identificação, mapeamento e quantificação das áreas urbanas do Brasil. Embrapa
- Fernandes E (2002) Do código civil ao estatuto da cidade: algumas notas sobre a trajetória do direito urbanístico no Brasil. *Urbana* 7(30):43–59
- Flaxman M (2010) Fundamentals of Geodesign. In: Buhmann E, Pietsch M, Kretzler E (eds) Proceedings of digital landscape architecture, Berlin/Offenbach, pp 28–41
- Freitas C (2020) Tecnologias de Geoinformação no planejamento territorial: novas formas de produção, compartilhamento e uso de dados espaciais. Doctoral Dissertation, UFGM Geodesignhub. Available: <https://www.geodesignhub.com>. Accessed on 10 Mar 2020
- Miller W (2012) Introducing Geodesign: the concept director of Geodesign services. Esri Press, Redlands

- Monteiro L, Moura ACM, Zyngier C, Sena I, Paula P (2018) Geodesign facing the urgency of reducing poverty: the Cases of Belo Horizonte. *Disegnarecon* 20(11):1–25
- Sieber R (2006) Public participation geographic information systems: a literature review and framework. *Ann Assoc Am Geogr* 96(3):491–507
- Steinitz C (2012) *A framework for Geodesign: changing geography by design*. ESRI Press, Redlands