

Lecture Notes in Civil Engineering

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Francesco Zullo
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Lucia Saganeiti *Editors*

Innovation in Urban and Regional Planning

Proceedings of INPUT 2023 - Volume 1

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Lorena Fiorini · Lucia Saganeiti
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Dedication

These volumes are the result of the collection of papers from the 12th International Conference on Innovation in Urban and Regional Planning (INPUT 2023): “Working for sustainable soil management and the role of land planning” and they are a tribute to the memory of Professor Bernardino Romano, who passed away prematurely on 1st September 2023, just before the conference took place. INPUT 2023 was possible due to his foresight and recognition in the academic world.

Prof. Bernardino Romano has been a full professor of Urban Planning at the University of L’Aquila. He had considerable influence on the development of his subject over a period of more than 30 years and provided much support to a generation of researchers and colleagues.

Since the beginning of his academic career, Prof. Romano has dedicated himself to the study of the relationship between the natural and built environment. He has been passionate about the issue of protected areas and ecological networks, expanding the existing meaning of concepts such as biopermeability and environmental continuity. In the eighties, he has been one of the first promoters of the institution of the main parks in Central Italy. His commitment in this direction was both academic and personal, through an intense activity at top level with the World Wide Fund for Nature (WWF) and the Italian Alpine Club (CAI). During these years, he has developed studies on land planning tools aimed at the establishment of both protected areas in Abruzzo region and the system of European Apennine Parks (APE). He has been a strong supporter of biodiversity conservation, and he made the knowledge of ecosystem dynamics a key point of his courses at university.

Prof. Romano has been a national reference for land take dynamics inspiring research and studies by many research groups. He always has been strongly convinced that land and urban planning plays a key role in sustainability of transformations. In fact, the dynamics of land transformation have always been a focus of his research and he has worked for years for drawing a precise and analytic description of the Italian settlement evolution. In the last period, he was active in the national discussion about drafting a law for stopping land consumption.

He has approached urban planning, ecology, and landscape both inside and outside the academic context, enriching the research with humanity. He has always been fascinated by the computational aspects of urban planning and by the possibility to explore new scientific approaches based on data analysis and indicator engineering. He has been a courageous explorer into this field, always looking for innovating the panorama of techniques and tools for spatial diagnosis.

Thanks to his creative vision, integrity, rigorous research, scientific excellence, and exceptionally broad intellectual horizons, he has left his imprint on the lives of students, PhD students, young researchers as well as many colleagues and collaborators from various institutions. He has also taught the value of autonomy of thought and collaboration.

He did so with passion, dedication, and desire to spread his great knowledge of Land Sciences.

He has left us with a significant legacy that we are going to preserve and share.

November 2023

CENTROPLANECO

Preface

The 12th International Conference on Innovation in Urban and Regional Planning (INPUT 2023) has been organized by CENTROPLANECO group of DICEAA—Department of Civil, Construction-Architectural and Environmental Engineering of the University of L’Aquila.

It took place in L’Aquila (Italy) on 6–8 September 2023 and has been titled “Working for sustainable soil management and the role of land planning”. Global challenges related to the sustainability of land transformations require the measurement of land transformations through specific indicators. Spatial planning and land management systems then play a crucial role in addressing issues of policy reform and investment, ecological transition, and sustainability in its three dimensions: environmental, economic, and social aspect. Integrating sustainability into our policies, strategies, and practices is fundamental to making a relevant impact with respect to current issues related to climate change, ecosystem services’ provision and the energy supply.

INPUT 2023 has given the opportunity to discuss such central issues and try to find and assess innovative and advanced methodologies to provide decision support systems through land science and indicator engineering.

Those proceedings represent the state of the art of modelling and computational approaches to innovations in urban and regional planning, with a transdisciplinary and borderless character to address the complexity of contemporary socio-ecological systems and following a practice-oriented and problem-solving approach.

In particular, this book presents the collection of 62 papers submitted at the INPUT 2023 Conference. The accepted papers, after a blind-review process, are here organized according to the thematic sessions of the conference:

- Geospatial earth data to support the restoration of soil ecosystems and implications for spatial planning (geo4sp).
- Geodesign for informed collaborative spatial planning and design.
- The urban digital twin: a new dimension for the land planning.
- Spreading porosity: the contribution of planning tools in increasing soil permeability.
- Research and standards for sustainable spatial planning (R&S4SP).
- Coastal planning: diagnostic tools to address physical, social, and environmental concerns.
- Territorial strategies in place-based and community-led energy transitions.
- Innovative simulations for urban planning: decoding configuration, morphology, and space.
- The energy transition of the built environment.
- Innovations in the 15 minute-city approaches: conceptual, data-driven, and practical developments towards a sustainable urban planning.

INPUT is a scientific community of Italian university and academic researchers who meet every two years and discuss issues from different fields related to urban and regional planning topics.

The latest editions have been hosted in Viterbo (2018), Turin (2016), Cagliari (2014), Potenza (2012), Catania (2021), and L'Aquila (2023).

During INPUT 2023 (L'Aquila), the conference recorded the following numbers:

- 20 parallel sessions have been organized from experts in different fields of research related to urban and land planning.
- 171 submitted abstracts.
- 124 accepted papers.
- 130 among online and in presence participants.

Keynote Speakers of the INPUT 2023 Conference

Three keynote speakers enrich the programme during three plenary sessions. Speeches have been held by:

Sara Meerow, School of Geographical Sciences and Urban Planning, Arizona State University

She is an associate professor in the School of Geographical Sciences and Urban Planning at Arizona State University where she leads the Planning for Urban Resilience Lab. She is an interdisciplinary scholar working at the intersection of urban geography and planning to tackle the challenge of making cities more resilient in the face of climate change and other social and environmental hazards, while at the same time more sustainable and just. Her current projects focus on conceptualizations of urban resilience, planning for urban resilience in a changing climate, and green infrastructure planning in a range of cities in the USA and internationally. She has published over 30 articles in academic journals, in addition to book chapters, reports, and popular press articles on these topics. She has a PhD in Natural Resources and Environment from the University of Michigan and an MS in International Development Studies from the University of Amsterdam.

Title of keynote speech: *Urban climate change resilience planning in theory and practice*

Jacques Teller, Local Environment Management and Analysis, University of Liège, Belgium

He is a professor of urban planning at the University of Liège, where he is leading the Local Environment Management and Analysis (LEMA) research group. He is a member of the Scientific Council of the Lab Research Environment (Vinci, ParisTech) and of the Efficacy Research Institute in France. His research typically combines urban governance issues with the modelling of urbanization and densification dynamics. It addresses the impacts of urbanization on energy consumption, heritage management, housing provision, and transport demand. He is presently working on the interactions between urbanization and exposure to floods, combining quantitative modelling and qualitative approaches.

Title of keynote speech: *Urban growth models for regulating urban densification in response to zero net land take policies*

Claudia (van der Laag) Yamu, Department of Built Environment, Oslo Metropolitan University, Oslo, Norway

She is an architect and urban planner. She is a professor of urban analytics at Oslo Metropolitan University. She is an expert on transport land use planning including people's behaviour in cities applying a wide range of analytical techniques including method and tool development at the forefront of virtual modelling. As a former project consultant, she excels in combining the theoretical innovations with practice-oriented solutions and has been involved in numerous international projects in industry and research. Claudia was awarded the prestigious Michael Breheny Prize in 2015 for her work on multiscale, multifractal urban planning models. She is an editorial board member for Springer's the Urban Book Series. She holds a PhD in Architecture from TU Wien connecting architecture, urban planning, and computer science and a PhD in Geography and Regional Planning in complexity-based modelling from Université de Franche-Comté. She dedicates her work to the development of sustainable cities and regions.

Title of keynote speech: *Accessibility and multiscale: fractal urban planning models*

Best Paper Award

Among the contributions, four papers have been selected for the Best Paper awards:

1. **Giovanni Cialone Best Paper Award** addressed to studies on inner areas, protected areas, and sustainable development. The award is dedicated to the memory of Giovanni Cialone: architect, passed away in 2020. He has been a CNR researcher (National Research Council) and served in the 1990s as an environmental councillor for the municipality of L'Aquila. He was highly committed to issues related to environmental protection and education, sustainability, and cultural enhancement of inner areas. He held the position of vice-president of the Gran Sasso–Monti della Laga National Park and was a member of the "Italia Nostra" association and a delegate of Slow Food. He enriched the debate about knowledge and defence of the territory defence, with a strong presence in the media and interventions in the political sphere, consistently displaying a well-regarded balance in his positions and numerous contributions of critique.

The award goes to the paper titled: *"The shapes of the adaptive ground design: formulation of a new taxonomy between spatial quality and ecological performance"* authored by: Simone Porfiri, University of Camerino (Italy).

2. **Giorgio Pipponzi Best Paper Award** addressed to studies on advanced GIS techniques. The award is dedicated to the memory of Giorgio Pipponzi: After his studies in geology and a PhD in geodynamics, he carried out highly professional positions in the Abruzzo Region, with the Basin Authority and the Civil Protection Service. He collaborated in the drafting of the Guidelines for the Seismic Microzoning Plans, in the development and management of computer databases as well as in the Level 3 Microzoning Pilot Project in the municipality of Sulmona. Since 2013 in the USRC, he has carried out his activity as Technical Geologist Directive Instructor, dealing with the geological problems inherent in the Reconstruction Plans and Private Reconstruction projects as well as being responsible for the GIS systems of the USRC. In 2019, he was appointed Head of the Procedure for the technical-economic investigation of the private reconstruction projects after the 2009 earthquake.

The award goes to the paper titled: *“The applicability of the urban digital twin in the detailed choices of the urban plan”* authored by: Federica Cicalese, University of Salerno (Italy).

3. **LAND Best Paper Award** addressed to studies on urbanization phenomena, densification, and land consumption. The award intends to enhance the merit of young researchers who will present scientifically relevant papers on topics related to urbanization phenomena, densifications, and contrasting land consumption. Work should focus on the role of urban and regional planning in urban growth management with the goal to meet specific needs while increasing the resilience of urban settlements. This award refers to the special issue *“Towards Sustainable Urban Development: New Approaches and Tools for Regeneration Strategies”*.

The award goes to the papers:

- *“Space Syntax vs Agent-Based Modelling in the maze of urban complexity: a critical comparison between top-down and bottom-up approaches and applications”* authored by: Federico Mara, University of Pisa (Italy).
- *“Urban energy resilience and strategic urban planning in Emilia-Romagna: evidence from three cities”* authored by: Giovanni Tedeschi, University of Parma (Italy).
- *“Digital Twin for urban development”* authored by: Angela Martone and Monica Buonocore, University of Sannio (Italy).

November 2023

Alessandro Marucci
Francesco Zullo
Lorena Fiorini
Lucia Saganeiti

Organization

The 12th International Conference on Innovation in Urban and Regional Planning (INPUT 2023) was organized by the CENTROPLANECO group of the DICEAA-Department of Civil, Building, Architectural, and Environmental Engineering of the University of L'Aquila. The composition of the organizing groups is shown in detail below.

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Geospatial Earth Data to Support the Restoration of Soil Ecosystems and Implications for Spatial Planning

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Geodesign for Informed Collaborative Spatial Planning and Design

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Integrating Ecosystem Services into Spatial Planning Processes: Sustainable Solutions for Healthier and Safer Urban and Rural Environments

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The Urban Digital Twin: A New Dimension for the Land Planning

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Supporting the Transition Towards Ecologically-Oriented Urban Planning: What's the Role of Early-Career Researchers? Innovative Findings, Experiences, and Ways Forward

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Towards Denser and Greener Cities? Methods and Indicators to Monitor Trends And Impacts in Support of Urban Planning and Policies

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Innovative Approaches and Methodologies for Driving Sustainable and Inclusive Urban Regeneration

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The Innovation of Urban Planning Tools for Energy-Resilient Cities

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Spreading Porosity: the Contribution of Planning Tools in Increasing Soil Permeability

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Research and Standards for Sustainable Spatial Planning

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Innovative Simulations for Urban Planning: Decoding Configuration, Morphology, and Space

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The Energy Transition of the Built Environment

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Smart Happy Region. Relationship Between Planning and Subjective Well-Being

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Innovations in the 15 Minute-City Approaches: Conceptual, Data-Driven, and Practical Developments Towards a Sustainable Urban Planning

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Climate Sensitive Planning: Re-defining Urban Environments for Sustainable Cities

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Densification and Urban Regeneration for Climate Adaptation in Sustainable Settlements

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Geoprocessing, Geodesign and Urban Parameters: Geoinformation and Co-Creation of Ideas in Urban Planning Teaching

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Abstract. This paper presents an academic experience that uses geospatial technologies and geodesign in urban planning teaching considering citizens' listening, place characterization and propositional design. In addition, it makes use of alternative urban parameters, the Completeness Indicators, applied in local scale urban planning in an undergraduate degree course in Architecture and Urbanism, at the Federal University of Minas Gerais, Belo Horizonte, Brazil. It was an experience of space diagnosis, followed by a geodesign workshop to propose changes to the central area of Belo Horizonte city. The students learned about co-creation of ideas with the goal to achieve the condition of completeness of the urban space, considering mobility, environment and place quality of the streets. As a result, it was possible to see from this experience that while the geoinformation and geovisualization of the study area were consolidated, the assertiveness of the proposals improved and the mastery over the study area by the students increased. Thus, the article is structured as follows: (i) brief presentation and description of the case study area; (ii) details of the methodological steps used in the course; (iii) report on the development of activities and experiences of the geodesign workshop with the students; (iv) results and analyzes of the experience and, finally, (v) considerations about the academic experience, methods and tools explored for local scale urban planning teaching.

Keywords: Urban spaces · Landscape quality · Environmental assessment · Co-creation process · Geovisualization · Complete streets

1 Introduction

The values applied to urban planning are constantly changing and are moving towards safe, lively, sustainable and healthy cities – returning to the human scale of the street [1]. This process highlights the role of the urban planner as decoder of collective demand, offering technical support and expertise for this transposition, necessarily in a collaborative way and to promote citizens' listening in the urban planning process [2, 3]. This way,

it is important training future urban planners to give support to collaborative planning processes and to having ability to translate collective values to designs that represents the place's people.

In this scenario, there is the Completeness Index for Complete Streets, based on 3 street functions or analytical contexts: environment, place and movement [4]. The completeness of the streets is the capacity of this free and public urban space to absorb its competing functions depending its vocation. In the study carried out, based on a bibliographical review of reference papers, it was proposed that the referred index be composed of 12 urban indicators that help both in the elaboration of ideas and in the evaluation of the performance of urban streets: (i) street afforestation, (ii) efficient drainage, (iii) environmental comfort, (iv) landscape quality, (v) active facades, (vi) flexibility of uses, (vii) universal accessibility, (viii) permanence spaces, (ix) road capacity, (x) road safety, (xi) mode connectivity, and (xii) active mobility.

At the same time that the use of georeferenced information supports the teaching of urban planning, it allows work with spatial variables and the investigation of phenomena related to spatial distribution. Then, the use of technologies of geoinformation qualifies the planning process by providing capture and distribution of geospatial data; giving support to the use of spatial analysis algorithms; allowing combination of variables; presenting syntheses in diagnostic and prognostic studies; and being a tool for propositional and co-creative processes.

Among the data capture resources, stands out the Volunteered Geographic Information (VGI), or crowd-mapping, with the potential to measure "citizens as sensors" through web-based tools, in which participants actively and voluntarily register their opinion using georeferenced points [5]. According to Davis Jr et al. [6] collaborative data collection can happen passively, when the user accepts general terms of digital platforms and has his behavior monitored, including his spatial location. But it can also be in active mode, when the user accesses a web-based platform to register his opinions using spatial location, and that this data will compose a visualization set for all interested users.

The Geodesign methodology is intended of the collective construction of proposals for alternative futures of a place, planning "with" and "for" the geographic place [3, 7–9]. In other words, it means recognizing the characteristics, vulnerabilities and potential of an area and developing local planning proposals through shared decision-making. Geodesign can be supported by geoinformation technology, and in this scenario, there are gains in scale of work, number of participants, flexibility and adaptability of the activities, geovisualization and data processing.

So, this article aims to present an academic experience that uses geotechnology and geodesign as a teaching process. In addition, it presents the use of alternative urban parameters, the Completeness Indicators, in an urban planning course at the local scale, of the undergraduate degree course in Architecture and Urbanism, at the Federal University of Minas Gerais, Brazil. The students learn the process of collective construction of ideas at the same time that they are informed about values that further the condition of completeness of the urban spaces. The article is structured as follows: (i) brief presentation and description of the case study area; (ii) details of the methodological steps used in the course; (iii) development report of activities and experiences of the geodesign

workshop with the students; (iv) results and analyzes of the experience and, finally, (v) considerations about the academic experience, methods and tools explored for urban planning teaching in local scale.

2 Materials and Methodological Steps

This article reports a methodological and teaching experience with an emphasis on alternative urban parameters and the use of geotechnology, in the course “Urban planning workshops: local planning problems”. The course took place in the second semester of 2022 for undergraduate students in Architecture and Urbanism, from the School of Architecture and Urbanism of the Federal University of Minas Gerais (EAU-UFMG), taught by professor Ana Clara Mourão Moura and doctoral student Ashiley Rosa. The content of the course consisted of five parts: (i) spatial perception and cognition; (ii) urban regulations and legislation; (iii) geoprocessing and spatial analysis; (iv) geodesign as a co-creation process; and (v) urban design proposal (Fig. 1). This experience had several by-products and a final product. The discipline functioned as an accumulation of geospatial, conceptual and theoretical information that were worked on and consolidated by the students collectively, but also individually, through proposals for urban designs at the end of the course.

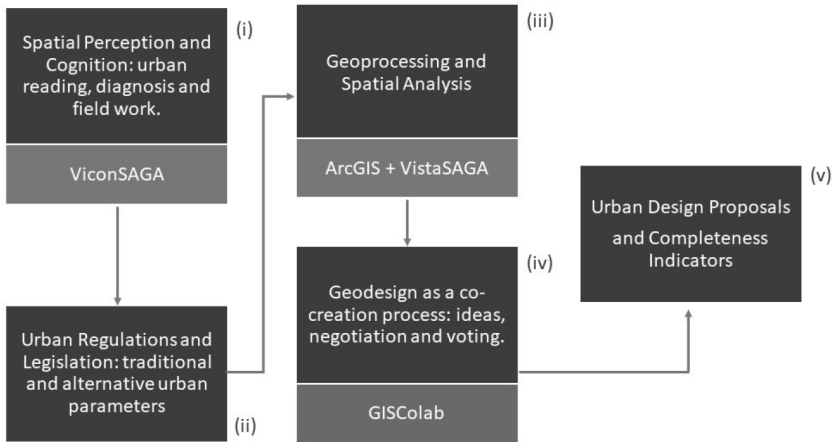


Fig. 1. Workflow, technological resources and products.

2.1 Study Area: Central Area of Belo Horizonte, Minas Gerais (Brazil)

The central area of Belo Horizonte city, capital of the state of Minas Gerais (Brazil), was planned by a team led by Aarão Reis and inaugurated in 1897. An urban design that presents the morphology of an orthogonal road network, composed by large avenues and by presence of squares and parks, under the strong influence of the Positivist School of

urban planning of “garden cities”. The initial plan intention was for the city to remain within the boundaries of the road that surrounds it, the so-called “Avenida do Contorno” (Contour Avenue), which measures 11.86 km and cover an area of 8.63 km². Nowadays it is a highly dense and verticalized area, that concentrates many points of economic and cultural-historical interests. It is also a reference for the education and health of residents of the capital and metropolitan region of Belo Horizonte.

The central area has an intense movement of people and vehicles that taking to some inconveniences large urban concentrations deal with when planned under the perspective and scale of the motor vehicle. The main results are less connection between people and the place, wide streets, a lot of noise, air pollution, among others. On the other hand, the central area is characterized by its tree-lined streets and wide sidewalks along the entire length of the then-planned garden city by Aarão Reis.

Regarding the hydrography of the region, most of the watercourses that pass through the central area were channeled, presenting as consequences flooding points in rainy period. This and another’s characterization and diagnosis of the study area was elaborated by the students in the academic experience, and is described in a specific section.

2.2 Technological Resources

ArcGIS was used for the processing of georeferenced data, allowing the reading of information, creation of maps and spatial analysis. In the course it was also used ViconSAGA [10], a web-based platform for volunteer mapping (VGI), contributing to the registration of impressions and urban reading in field camp by the students. For the geodesign step, the web-based GISColab platform was used.

The VGI platform used, ViconSAGA, was developed by Professor Tiago Marino from Federal Rural University of Rio de Janeiro (UFRRJ). It is intended for the voluntary and active capture of spatial information recorded by the user. The project creator is free to define an initial visualization point and zoom (being able to choose satellite, terrain or road map views), to be presented in Google Earth for the beginning of navigation by users, as well as the graphical symbology for the records and the list of attributes that the participant must answer when registering a contribution. The Vicon SAGA application is free of charge and accepts the import and export of KML files (Google Earth) for mass registration of records in the system, SHP (ArcGIS shapefile) for the production of thematic maps, XLS (Microsoft Excel) and CSV (Comma Separated Values) for general analysis of records from a locality, which means wide system interoperability [11].

The GISColab platform [12] was initially proposed to work as an SDI (Spatial Data Infrastructure) by GE21 Geotechnologies, and it was adapted, through task support scripts, by Moura and Freitas [13] to be used as a Brazilian platform for geodesign and co-creation. The platform allows the visualization of a collection of maps, presents tools to improve geo-visualization, resulting in spatial analysis and proposition of georeferenced ideas. Maps can be organized in a geoserver, but they can also be loaded through connection with other SDIs, or additional layers can be inserted by participants during the workshop. There are dynamic resources to supported the geodesign workshop stages. In synthesis, it works with WMS (Web Map Service), WFS (Web Feature Service) and WPS (Web Coverage Service) resources.

Finally, VistaSAGA [14] was used, an environmental analysis system with an application available for desktop that provides maps and reports as results that support the decision-making process. The application was developed by Jorge Xavier da Silva [15] and is available free of charge from the Federal University of Rio de Janeiro (UFRJ). The use of VistaSAGA made it possible to carry out the Multicriteria Analysis, combining the variables as a synthesis of the collected data and urban analyzes developed by the students.

3 Development

In the spatial perception and cognition stage, students first took theoretical classes on Spatial Perception, from Kevin Lynch's perspective [16], carrying out experiments to identify the urban elements according to the author. They also had theoretical class on spatial cognition, according to the perspective of Gordon Cullen [17], carrying out field work through the central area of Belo Horizonte. The study area was divided into 12 subareas, and in turn, one student per subarea. Still at the same stage, students had contact with the concept of Completeness Index proposed by Rosa [4], which consists of a set of urban indicators that together contribute to the complete-ness and quality of urban spaces with emphasis on the streets.

The students used the technical support ViconSAGA application to capture their perception and cognition in field camp, and also incorporating the concepts of topophilia and topophobia [18]. While registering their opinions, they were also instructed to mark the identified completeness indicators. The use of ViconSAGA could be directly in their mobiles or tablets, but some of them preferred registering on paper and pictures, and use a browser on a computer in a posterior time, in their home, due to insecurity risks of been stolen on street. The initial visualization point was the Sete de Setembro Square, an urban landmark city, and students scrolled through the tabs: (i) "locate", in which they should chose a position in the record (point); (ii) "fill in", in which they should mark the indicators identified in the section analyzed, and could register comments; and the tab (iii) "image", in which they could insert photos. A total of 224 records were made (Fig. 2). In parallel to spatial analysis, students learned about regulations and urban legislation, to understand the impact of urban laws and parameters in the land use and city scape of Belo Horizonte.

In the geoprocessing and spatial analysis stage, the diagnosis and analysis of completeness indicators was performed. The students developed an important work of creating maps in the EA-UFGM Geoprocessing Laboratory, considering social, environmental, land use and volumetric landscape aspects, identifying main characteristics, vulnerabilities and potentialities of the area, with emphasis on the 12 completeness indicators. Students created an urban analysis map for each indicator in ArcGIS, resulting in 12 thematic maps based on available spatial data (Fig. 3).

From the 12 specific maps, 4 Multicriteria Analysis Weighted Sum maps were prepared in VistaSAGA (Fig. 4), for the contexts of environment, movement and place, and a general synthesis. The weights applied in the completeness indicator variables were discussed with students in a Delphi consultation (Table 1). For the final synthesis, the same importance was adopted for all 3 contexts, generating a global diagnostic scenario regarding the completeness indicators for the central area of Belo Horizonte (Fig. 5).



Fig. 2. Vicon SAGA interface with the records and subdivision of the study area.

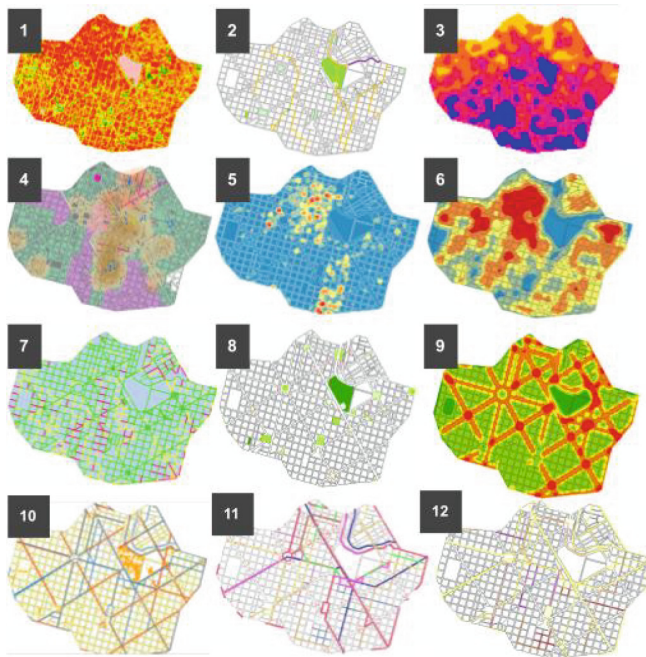


Fig. 3. Set of thematic maps created in ArcGIS for the diagnosis of the study area - Central Area of Belo Horizonte.

In the co-creation stage, a Geodesign workshop was held on in the classroom, dividing the students into 3 groups. They were first asked to do the reading enrichment, that is the analysis of maps followed by the annotations of alerts, additional information, and general comments. In the second step, also in groups, they were asked to create ideas as diagrams, associating them with a title, a description and informing to which completeness indicators it could contribute to (Fig. 6). The groups worked in a cycle,

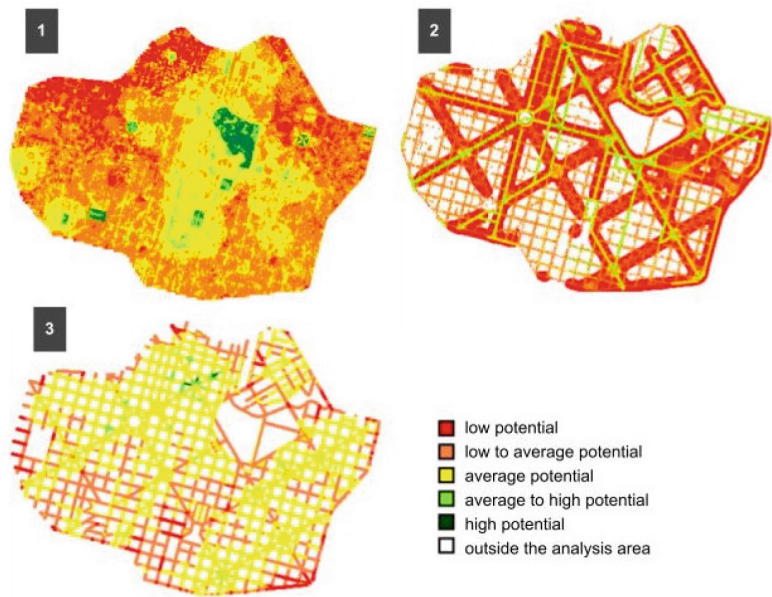


Fig. 4. Multicriteria Analysis Maps for: (i) Environmental, (ii) Movement, and (iii) Place.

Table 1. Weights assigned for the multicriteria analysis

Indicators	Weights	Contexts	Weights
street afforestation	20	environment	33,33
efficient drainage	20		
environmental comfort	20		
landscape quality	30		
active facades	25	place	33,33
flexibility of uses	25		
universal accessibility	25		
permanence spaces	25		
road capacity	15	movement	33,34
road safety	25		
mode connectivity	30		
active mobility	30		

going from one context to the other (environment, place and movement). To measure dynamically the impact of the ideas, GISColab provided a widget with a histogram

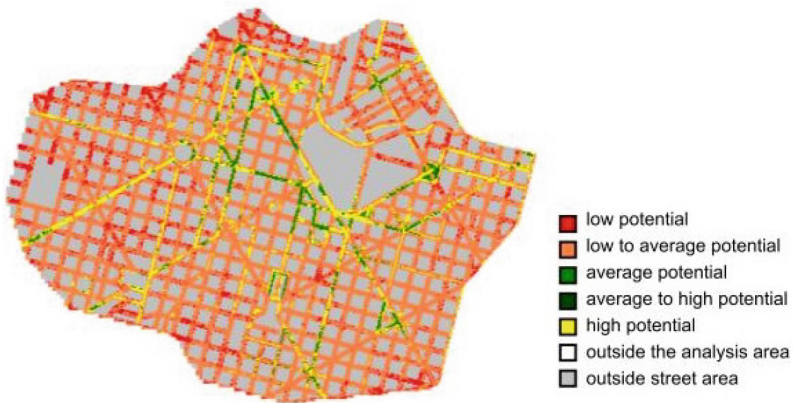


Fig. 5. Multicriteria Analysis Map: Synthesis Indicators of Urban Completeness.

for monitoring the distribution of number of ideas per completeness indicator, so that students could control their performance during the workshop (Fig. 7).



Fig. 6. Proposition of ideas: geodesign workshop in the classroom.

Finally, in the last stage the students were asked to develop individually an urban design, as a consolidation and application of the values and knowledge built throughout the course. The students developed urban design proposals contemplating the completeness indicators and based on the ideas previously collectively negotiated in the workshop. The graphic representation was free and each student had only to describe their ideas briefly and textually. The results of this stage were solid, demonstrating the students' reliability in proposing solutions to the identified problems in qualified proposals in terms of completeness indicators.

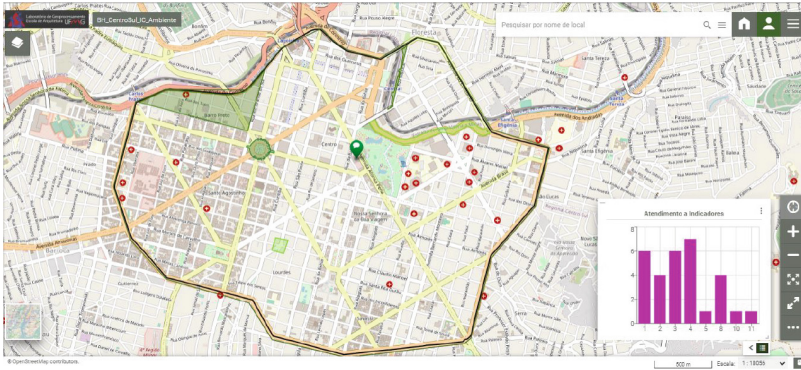


Fig. 7. Context interface in the GISColab platform.

4 Results and Discussion

The data collected in the survey field by the students using ViconSAGA was systematized and analyzed in maps of Kernel Density, resulting 12 maps of the spatial distribution, one of each indicator. These maps were combined in 3 syntheses, according to the contexts of environment, movement and place, and a final combination of the 3 contexts was also produced (Fig. 8). From this analysis, it could be seen that the distribution of the existing conditions of completeness indicators along the study area were concentrated in some axes, and were considered the more qualified area also in the perceptions students registered.

In this sense, the students learned about different geospatial analyses: a technical analysis composed by official public data, and a analysis resulted from field camp that they registered using technological VGI tool. In both cases, they produced 12 initial maps, followed by 3 multicriteria synthesis map and a final synthesis map. They learned about knowledge driven and data driven analysis [19].

The time allocated to the final task (urban design) was very short, just being 3 classes. However, it was possible to observe that the training acquired by the students in earlier stages (reading the territory by perception and cognition, data representation through field collection and mapping by geoprocessing, multicriteria analysis for understanding the existing place relationships, and geodesign stage for the collective co-creation of initial ideas) was fundamental for the execution of this final activity. In the final stage, the students showed ability to elaborate complex and qualified proposals, which resulted from well-conducted previous processes.

In the final proposals prepared by the students, some areas were presented in more than one idea, such as solutions for João Pinheiro Avenue and Andradas Avenue. It can be seen in the proposals that some indicators were more frequent than others, being landscape quality the most explored, and, on the other hand, road capacity being the least explored indicator (Fig. 9). In this way, when defining the importance and weights to the indicators in multicriteria analysis, the environmental context was the most relevant (43.04%), followed by the place context (29.11%) and finally the movement context (27.85%) in the final proposals. All proposals contemplated completeness indicators,

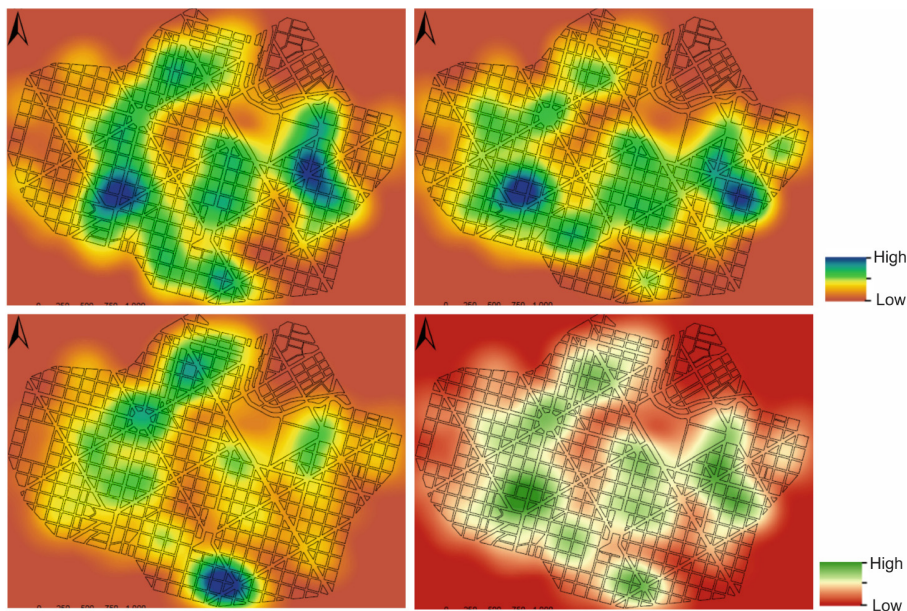


Fig. 8. Kernel Density Maps from Vicon SAGA records.

and students justified their ideas using the previously constructed maps, evidencing the importance of measurable urban metrics in the project teaching-learning process.

			Proposals		weight	sum	%
			frequency	importance			
Completeness Indicators	environment	1. street afforestation	10	high	10	34	43,04
		2. efficient drainage	8	medium to high	7		
		3. environmental comfort	8	medium to high	7		
		4. landscape quality	11	high	10		
	place	5. active facades	7	medium	5	23	29,11
		6. flexibility of uses	7	medium	5		
		7. universal accessibility	6	medium to low	3		
		8. permanence spaces	10	high	10		
	movement	9. road capacity	3	low	1	22	27,85
		10. road safety	9	medium to high	7		
		11. mode connectivity	9	medium to high	7		
		12. active mobility	8	medium to high	7		
						79	100

Fig. 9. Frequency and importance analysis of completeness indicators in urban design final proposals.

5 Conclusions

The framework and steps proposed for the course allowed the students to consolidate and build knowledge, while they passed through the methodological stages (in class hours) of urban reading (32h), regulations and urban legislation (12h), geoprocessing and spatial analysis (36h), geodesign as a co-creation process (20h), and urban design work (20h). There was a progressive expansion in the understanding of the theme of urban planning on a local scale. In this way, the individual proposal stage, the last one, which is usually more difficult and developed in many hours, happened in a more organic way, resulting from the qualification and understanding previously built.

The use of measurable criteria, such as completeness indicators during the geodesign workshop, favors that the processes were guided, presenting objectives and goals to be met. They used defensible and clear criteria to create ideas, for the judgments and of proposals, to measure the impacts of the suggested ideas, as well as a support to decision-making in the negotiation and proposals acceptance.

It is important to highlight that the use of different technological applications was not a problem, as all of them had the condition of interoperability. It was possible to go, for example, from ViconSAGA and from VistaSAGA and to ArcGIS, and from them to GISColab. Thus, learning about geoinformation technologies and geospatial data was also favored throughout the course in a practical and applied way.

Finally, the students were able to learn about the role of the architect and urban planner as a decoder of the collective will, as a team member and in co-creation activities, and finally, the importance of the moment when they could and should have an authorial action, bringing their individual creativity as a development to the previously created collective agreement.

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