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Computational Science and Its Applications – ICCSA 2021

21st International Conference
Cagliari, Italy, September 13–16, 2021
Proceedings, Part VI

6 Part VI

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Preface

These 10 volumes (LNCS volumes 12949–12958) consist of the peer-reviewed papers from the 21st International Conference on Computational Science and Its Applications (ICCSA 2021) which took place during September 13–16, 2021. By virtue of the vaccination campaign conducted in various countries around the world, we decided to try a hybrid conference, with some of the delegates attending in person at the University of Cagliari and others attending in virtual mode, reproducing the infrastructure established last year.

This year's edition was a successful continuation of the ICCSA conference series, which was also held as a virtual event in 2020, and previously held in Saint Petersburg, Russia (2019), Melbourne, Australia (2018), Trieste, Italy (2017), Beijing. China (2016), Banff, Canada (2015), Guimaraes, Portugal (2014), Ho Chi Minh City, Vietnam (2013), Salvador, Brazil (2012), Santander, Spain (2011), Fukuoka, Japan (2010), Suwon, South Korea (2009), Perugia, Italy (2008), Kuala Lumpur, Malaysia (2007), Glasgow, UK (2006), Singapore (2005), Assisi, Italy (2004), Montreal, Canada (2003), and (as ICCS) Amsterdam, The Netherlands (2002) and San Francisco, USA (2001).

Computational science is the main pillar of most of the present research on understanding and solving complex problems. It plays a unique role in exploiting innovative ICT technologies and in the development of industrial and commercial applications. The ICCSA conference series provides a venue for researchers and industry practitioners to discuss new ideas, to share complex problems and their solutions, and to shape new trends in computational science.

Apart from the six main conference tracks, ICCSA 2021 also included 52 workshops in various areas of computational sciences, ranging from computational science technologies to specific areas of computational sciences, such as software engineering, security, machine learning and artificial intelligence, blockchain technologies, and applications in many fields. In total, we accepted 494 papers, giving an acceptance rate of 30%, of which 18 papers were short papers and 6 were published open access. We would like to express our appreciation for the workshop chairs and co-chairs for their hard work and dedication.

The success of the ICCSA conference series in general, and of ICCSA 2021 in particular, vitally depends on the support of many people: authors, presenters, participants, keynote speakers, workshop chairs, session chairs, organizing committee members, student volunteers, Program Committee members, advisory committee members, international liaison chairs, reviewers, and others in various roles. We take this opportunity to wholehartedly thank them all.

We also wish to thank Springer for publishing the proceedings, for sponsoring some of the best paper awards, and for their kind assistance and cooperation during the editing process.

We cordially invite you to visit the ICCSA website https://iccsa.org where you can find all the relevant information about this interesting and exciting event.

September 2021

Osvaldo Gervasi
Beniamino Murgante
Sanjay Misra

Welcome Message from the Organizers

COVID-19 has continued to alter our plans for organizing the ICCSA 2021 conference, so although vaccination plans are progressing worldwide, the spread of virus variants still forces us into a period of profound uncertainty. Only a very limited number of participants were able to enjoy the beauty of Sardinia and Cagliari in particular, rediscovering the immense pleasure of meeting again, albeit safely spaced out. The social events, in which we rediscovered the ancient values that abound on this wonderful island and in this city, gave us even more strength and hope for the future. For the management of the virtual part of the conference, we consolidated the methods, organization, and infrastructure of ICCSA 2020.

The technological infrastructure was based on open source software, with the addition of the streaming channels on YouTube. In particular, we used Jitsi (jitsi.org) for videoconferencing, Riot (riot.im) together with Matrix (matrix.org) for chat and ansynchronous communication, and Jibri (github.com/jitsi/jibri) for streaming live sessions to YouTube.

Seven Jitsi servers were set up, one for each parallel session. The participants of the sessions were helped and assisted by eight student volunteers (from the universities of Cagliari, Florence, Perugia, and Bari), who provided technical support and ensured smooth running of the conference proceedings.

The implementation of the software infrastructure and the technical coordination of the volunteers were carried out by Damiano Perri and Marco Simonetti.

Our warmest thanks go to all the student volunteers, to the technical coordinators, and to the development communities of Jitsi, Jibri, Riot, and Matrix, who made their terrific platforms available as open source software.

A big thank you goes to all of the 450 speakers, many of whom showed an enormous collaborative spirit, sometimes participating and presenting at almost prohibitive times of the day, given that the participants of this year's conference came from 58 countries scattered over many time zones of the globe.

Finally, we would like to thank Google for letting us stream all the live events via YouTube. In addition to lightening the load of our Jitsi servers, this allowed us to record the event and to be able to review the most exciting moments of the conference.

Ivan Blečić
Chiara Garau

Organization

ICCSA 2021 was organized by the University of Cagliari (Italy), the University of Perugia (Italy), the University of Basilicata (Italy), Monash University (Australia), Kyushu Sangyo University (Japan), and the University of Minho (Portugal).

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Geomatics in Forestry and Agriculture: New Advances and Perspectives (GeoForAgr 2021)

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Geographical Analysis, Urban Modeling, Spatial Statistics (GEOG-AND-MOD 2021)

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12th International Symposium on Software Quality (ISSQ 2021)

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10th International Workshop on Collective, Massive and Evolutionary Systems (IWCES 2021)

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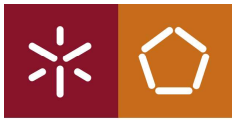

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Contents – Part VI

Using Geodesign to Plan the Future of Macapa Metropolitan Region, State of Amapa, Brazil: A Support to Expanding Collaborative Technical Performance

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Abstract. The experience is part of a broader one, Geodesign Brazil: Trees for metropolitan regions, composed of a set of workshops that were held in twelve Brazilian metropolitan areas, that in Amapa was conducted by technicians of two planning state departments. The workshop aimed to develop dialogs and proposals for alternative futures to the metropolitan region, targeting the years of 2035 and 2050. The goal was to discuss ten main topics: vegetation, hydrography, housing, transportation, institutions, trade and industry, agriculture, energy, tourism and culture, and carbon credit. The GISColab platform was used as a tool for registering opinions, alerts, ideas and voting of designs for each scenario. The workshop was developed over four stages: reading enrichment and note creation; creation of proposals with that continued the existing planning; creation of proposals with some innovations; creation of proposals with many innovations and a final voting. The experience pointed to an active participation of the actors in the discussion process, but a limitation in changing from analysis to proposals, mainly accepting innovative ideas, a fact possibly related to the wide technical experience of the participants in public agencies, who acted during the meetings in the same way that they do in their professional practices: discussing the difficulties and consequences of implementing innovations. However, as a result, when comparing the first designs to the last ones, it was possible to observe improvements in performance and an adherence to a new way of planning.

Keywords: Collaborative planning · Geodesign · GISColab · Amapa

1 Introduction

There are several challenges to overcoming the distance between what is proposed in urban planning and its actual effects in urban landscape. One of them is the distance that separates technical knowledge and the empirical knowledge, borne out of inhabitants' everyday lives. Understanding the information produced by technicians is a task that

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requires abstract thought and codification, and empirical knowledge is often disregarded. Therefore, citizen participation in the decisions that define urban space are becoming ever smaller.

Despite significant advances in laws and planning within Brazilian cities, particularly after the Statute of Cities, from 2001, citizen participation is still incipient, and so-called democratic processes simply fulfill bureaucratic guidelines without including citizens in collective decisions.

In Geodesign, information is considered the bedrock for everything else. Data production would be the moment in which citizens could provide information and the transformation of that data would bring about a debate regarding the needs and potential uses of urban spaces. The careful consideration of the data contributes to a better understanding of the collective values and culture, as they relate to different social groups. The planning scale for geodesign is somewhere in between that of geoscience and architecture. In geodesign, change and sustainability are sought through a combination of factors, such as quantity, cost, and quality.

Moura and Santana [1] argue that there is a new role for technicians. They are no longer to act in a purely authorial fashion, but rather as those who decode the collective will, which, in turn, requires carefully listening to the communities involved. Geodesign then emerges as a methodology that provides support to shared creation and decision-making processes. It seeks to build a collective planning that stems from the information regarding the territory, resorting to the potentialities of Geographic Information Systems. In other words, a geodesign process can use data distribution models in territories, so that relevant layers can be combined and used for debate, which later allows to construct syntheses regarding a given field of study [2].

According to Moura [2], geodesign has shown itself as a method supported by geoinformation technology and sharing of data, information and knowledge on the territory, which ultimately results in a co-built agreement, a portrait of citizen values. It offers the possibility of building a collaborative form of planning, in which different social agents can contribute to decision-making. Aside from that, it is also a way towards overcoming public hearings, that simply fulfill a norm and do not promote citizen power [3].

The proposal of the International Geodesign Collaboration (IGC[1]), a geodesign study network coordinated by Carl Steinitz, is to create a framework for optimizing co-creation processes. According to Steinitz [4], the stages of geodesign are comprised of six models: Representation, Processes and Evaluation - which should be priorly developed by technicians - and Change, Impact and Decision - developed during a participatory planning workshop.

Moura and Freitas [5] argue that the form of geodesign proposed by Steinitz [4] has faced challenges in the context of Brazil, particularly regarding the languages, modes and expression, visualization of information and access to final and partial products. The changes that were made in the framework resulted in the Brazilian platform GisColab, developed by the aforementioned authors. The platform focuses on developing a methodology that is comprised of four stages: 1) Reading enrichment and annotation; 2) proposal creation; 3) dialogs and negotiation; and 4) final voting.

[1] https://www.igc-geodesign.org/.

Through the GisColab platform, and Geodesign's concepts of participation and collaboration, and as part of an international experiment - Geodesign Brazil: Trees for metropolitan regions[2]- a workshop was conducted regarding the Macapá Metropolitan Area (MMA) in Amapá State, Brazil. The goal of this paper is to describe the experience derived from said workshop, remarking the challenges and possibilities offered by digital platforms in regional-scale urban planning. For the workshop, the platform was connected to a database with a collection of maps built by the Geoprocessing Lab at the School of Architecture at UFMG using data collected in the INDE platform (National Spatial Data Infrastructure).

In these cases, the workshops are of academic nature and, therefore, do not intend to build proposals that will actually take place. The proposed exercise is to investigate on-line participation methods use as planning tools and provide, through dialog and negotiation, the experience of collectively planning a metropolitan area for the years of 2035 and 2050. The recently-created MMA has a unique landscape and culture, considering it is located in the far-northern area of the country, within the Equator Line and in the vicinity of Amazon River's delta. Thus, we expect that the results of the different spatial analyses, tables and charts that were built using a questionnaire at the end of the workshop, can express the relationship between citizens and their territory.

2 Case Study MACAPÁ Metropolitan Area

Macapá Metropolitan Area, located in the state of Amapá, with a total area of 22.339,46 km^2 accounts for 14,94% of state's total territory (see Fig. 1). According to IBGE data 2020, the estimated population of Macapá is 512.902, 123.092 for Santana and 22.053 in the city of Mazagão. The population of the three cities that form MMA accounts for 76% of the total population of Amapá.

MMA is located on the left bank of the mouth of the Amazon River, which potentially favors ports designed for exporting, and also attractive for services and commerce. Its cultural and landscape values contribute to tourism - for both business as well as ecotourism -, given that aside from the mouth of the Amazon River, the city of Macapá is also crossed by the Equator Line (see Fig. 2) and is strongly influenced by the Marajoara islands, in the neighboring state of Pará.

Amapá's climate is equatorial (warm and humid), with two well defined seasons. A rainy winter, that lasts from January to June, and a dry summer, that lasts the remainder of the year. Its vegetation cover is diversified, including Cerrado (savanna), Firm Ground Forests (typical of the Amazon Forest) and Floodplain Forests, with mangrove vegetation in its shores (see Fig. 3). The Firm Ground Forest, located in northern Mazagão, is preserved as part of a conservation unit named Amapá State Forest or FLOTA/AP, created in 2006 with the goal of achieving sustainable use of forest resources in the state

[2] The experiment was a joint effort by twelve Brazilian metropolitan areas, through ten federal universities (UFMG, UFRRJ, UFJF, USP, UFCF, UFPE, UFG, UFPA, UFT, UNIFAP), two state universities (UDESC and UNESP at Rio Claro) and two offices related to the secretary of planning (SEMA and STRAP). The common goal was to discuss proposals for different scenarios, in the years of 2035 and 2050. The goal was to be part of the IGC's global project.

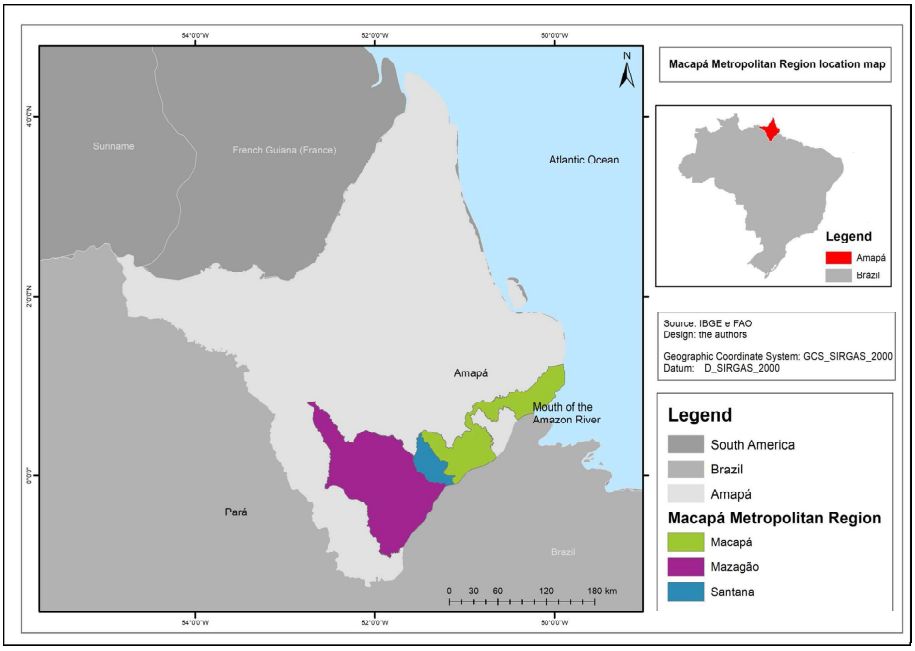

Fig. 1. Macapá metropolitan area map.

of Amapá. The area is destined for the exploitation of both wood/lumber-related and non-related products in a sustainable fashion. To the south, human occupation encompasses most of the metropolitan area, but the cities of Macapá and Santana are much more connected than the other parts of MMA.

The Accessibility and Capillarity map shows how the low-density of pathways is widespread in the region. Macapá bears a high density, in line with its status as the capital city of Amapá state (see Fig. 4).

The occupation of Amapá's territory took place during the Second World War and during the post-War period. According to Porto [6], the 1940's saw the beginning of iron extraction in the Vila Nova River, with Hanna Corporation in 1945, and manganese in the Serra do Navio region in 1957–1997 by Indústria de Comércio e Mineração (ICOMI). The cities of Santana and Serra do Navio were built alongside the mining infrastructure (railroad, port, road and a hydroelectric plant), propelled by ICOMI and heavily influencing the urbanization of Amapá.

Brazil, worrisome of invasions and foreign exploitation of its natural resources, worked towards incorporating the area through public projects for highways, under the slogan of "integrar para não entregar", that is "integrate to not give away". On Fig. 5, we can see this take place between the decades of 1950 and 1970, when Macapá, Santana and Mazagão had a population leap from 25.666 inhabitants (1950) to twice as much in 1960, reaching almost 100.000 people in the 1970's. However, in the remainder of Amapá state, growth remained stagnate. From 1991 onwards the population of the cities that would form the metropolitan area grows by an extra 100.000 inhabitants, which is

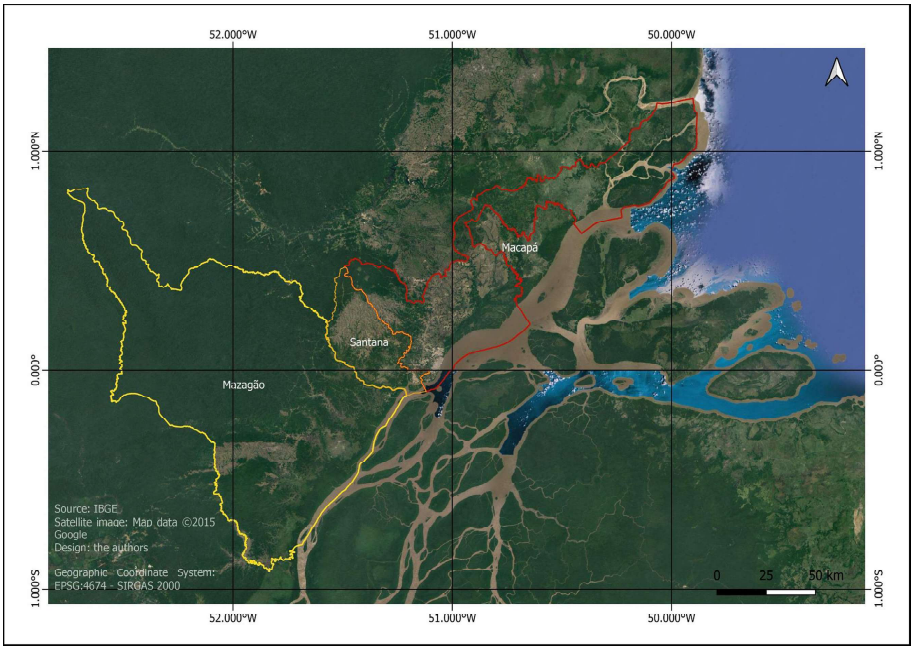

Fig. 2. The mouth of the Amazon river and Macapá metropolitan area.

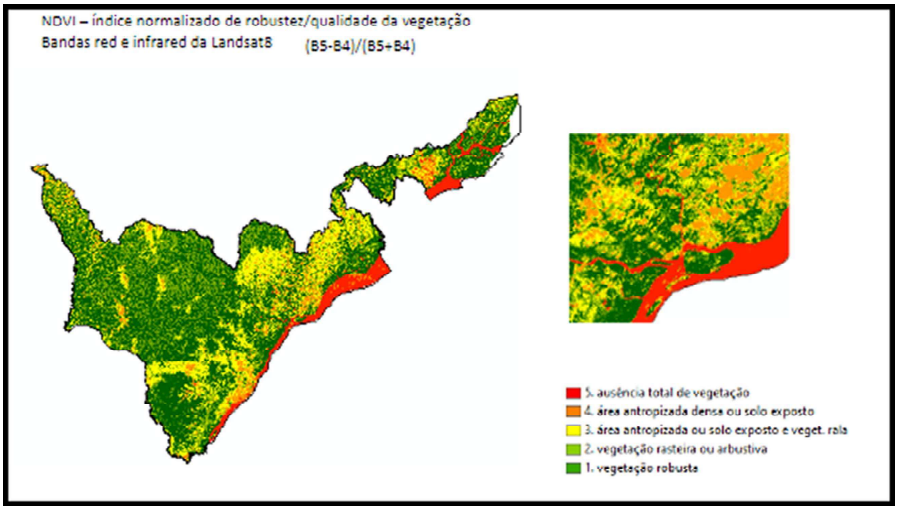

Fig. 3. Normalized difference vegetation index/vegetation quality.

visible over the next decades, due to migratory influxes. According to Porto [6], this is due to the following factors:

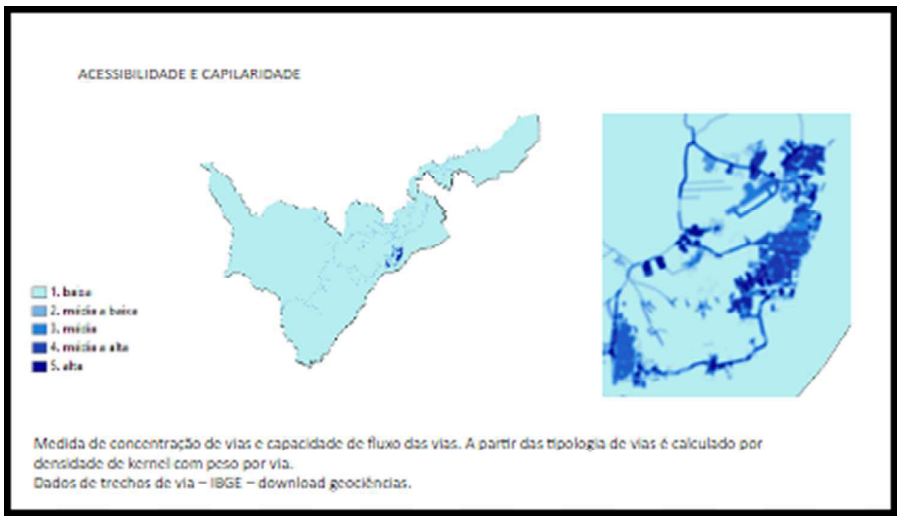

Fig. 4. Accessibility and capillarity

"The occupation of Amapá's territory as a way to protect the national border; the creation of the Federal Territory of Amapá; transferring the capital to Macapá; investments in mining in Amapá's territory (gold, manganese) and the Macapá area; establishment of mining and wood-timber industries (ICOMI and AMCEL); creation of Companies towns (Serra do Navio; Vila Amazonas); expansion of the agricultural frontier; local political actions (elections for city councilors, congresspeople and senators; new municipalities being created); Amapá statehood; creation of protected areas (conservation units and indigenous reservations); creation of the Macapá and Santana Free Commerce Area; hopes for new investments (bridges being built on the Oiapoque and Matapi rivers); paving of the BR-156 highway; the new mining cycle; expectations regarding the creation of the Macapá Free Trade Zone; the growth acceleration program (PAC); stimulus to agricultural businesses; the creation of the Macapá and Santana Metropolitan Area (2003); the integration of Magazão into the Macapá Metropolitan Area (2016)".

The state of Macapá created the Macapá Metropolitan Area (MMA), comprised of the cities of Macapá and Santana, through the Complimentary Law N. º 0.021, in February 26th, 2003 [7]. Thirteen years later, Mazagão is included in MMA, under the Complimentary Law N. º 95, of May 17th, 2016 [8]. According to AMAPÁ [9] "the lines of common interest between the three cities of the Metropolitan Area are basic sanitation, urban mobility, health, law enforcement, education, housing and integrated planning for sustainable economic, social and territorial development." According to Porto [6], Mazagão received stimulus to conclude its infrastructure building, particularly the bridge of Matapi river, which allows for greater connectivity, flux and fluidity between the cities of the metropolitan area. However, it is possible to note the cities that form MMA hold a somewhat timid conurbation between Macapá and Santana.

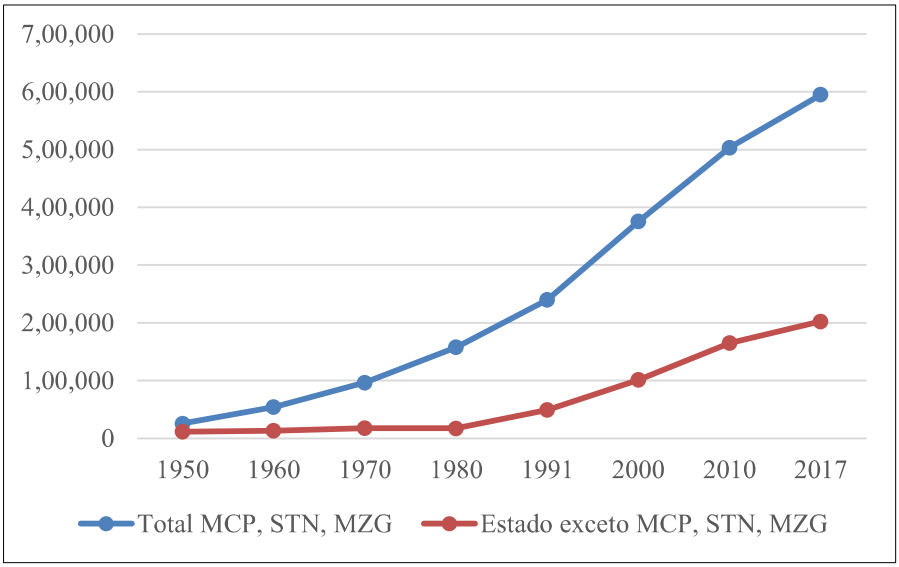

Fig. 5. Population of Macapá, Santana and Magazão [6].

The ressaca (see Fig. 6) was defined by the Environmental Law N. ° 948/48 of the City of Macapá, as: "Water accumulation bays, influenced by the behavior of tides, rivers and rain drainages". Neri [10] describes the ressaca as the following:

"Ressaca is a regional expression used to designate an ecosystem that is typical of Amapá's shores. They are areas that fit into Quaternary terrains, which behave as natural water reservoirs, characterized as a complex and unique ecosystem that is subject to the regime of the tides, as part of an intricate set of canals and streams (igarapés 2), and the seasonal rain cycle, therefore presenting a flood season (January to June) and a drought season (August to December)".

Fig. 6. Ressacas in their natural state, in the city of Macapá, and Occupations.

There was an intense migratory flow into these cities, particularly Macapá, due to the promising opportunities for employment, and many were also attracted by access to better installations like hospitals and schools. However, the number of unemployed was greater than the work available, which resulted in many informal workers [10]. Their housing alternative was the occupation of the ressacas, because even though there was no access to public services or infrastructure, their location was often close to the urban center, making them an attractive choice. The houses built over stilts (palafitas) have no access to basic sanitation, which is a risk to both human health and the environment. Moreover, fish farms (pisciculture) pose a major risk to the fauna, since exotic fish are bred as a source of income.

Despite all these adversities, a research conducted by Souza [11] showed that 100% of inhabitants of the Lagoa dos Índios believe that the Ressacas offer good conditions for living. However, Neri [11] notes that the Lagoa dos Índios is unique since it offers access to all public services and most of its inhabitants have fixed-income jobs (see Fig. 6). Although it poses a risk, people still have a positive view of life in ressaca areas in virtue of their location and the access to services and infrastructure.

3 Workshop: Tools and Methods

In virtue of the IGC's global project, a total of ten key topics were chosen for discussion, in the form of systems that were evaluated during the collaborative process: vegetation, hydrography, housing, transportation, institutions, commerce and industry, agriculture, energy and carbon credit. The geospatial data that best described each system were gathered according to their availability in municipal, state and federal databases.

The data was processed and organized into a collection of maps, and then exported to the GisColab platform. This process was in charge of the coordinators of the experiment, at the Geoprocessing Lab at Minas Gerais Federal University's School of Architecture. (Geoproea - UFMG). The data was retrieved from platforms belonging to public institutions and freely available for download, followed by an upload to the platform using WFS (web feature service), since direct access via WMS (web map service) is not supported by these platforms and the data would require further processing to fit within the goals of the study.

The workshop was conducted over the course of four virtual sessions in March 2021. There 18 people attending, mostly university and public service personnel, a lot them working as technicians for public offices dedicated to territorial planning. Participants were divided into two work groups, "Group A" and "Group B", which worked with different time horizons. The former would develop scenarios for the year of 2035, whereas the latter would focus on proposals for the year of 2050.

A series of videos explaining how to use the platform and the goals for each day of the workshop were presented to help participants access the platform, share information and create proposals. The videos were quite relevant for participants who were not familiar with the functionalities of GisColab. They were presented at the start of each session.

3.1 Day 1 – Reading Enrichment and Note Creation

The first stage of the workshop involved understanding the platform and its layers, after which notes were taken regarding problems and potentialities. The session started by welcoming participants and explaining the general aspects, as well as the goals, of the workshop. Participants were then divided into each group, where they would be guided by a "mediator", who explained the platform and the available data, as well as provided support in the creation of the notes.

Once participants were distributed in online chatrooms, they were explained how the GisColab platform works with special regard to how the spatial data for each system could be visualized and how the color scheme for the captions was organized. Participants were encouraged to access the platform from their own computers and read each one of the layers, to then provide their opinion regarding their usefulness for creating notes.

Once the reading part was done, the workshop proceeded with the discussion regarding the aspects of the area that were worth highlighting and which were not yet provided in terms of data. Said process resulted in the creation of specific notes about the area, which could be later retrieved, during the proposal creation stage. These notes were characterized as observations, problems, potentialities, and alerts regarding the Macapá Metropolitan Area, according to each participant's views.

The notes made by each participant were included in the platform by the mediator, with captions adhering to the color scheme and symbols that corresponded to each of the ten previously defined systems. Participants were informed of the possibility to include new notes over the course of the week, between the first and second encounter, as a way to further advance discussions on the region (see Fig. 7).

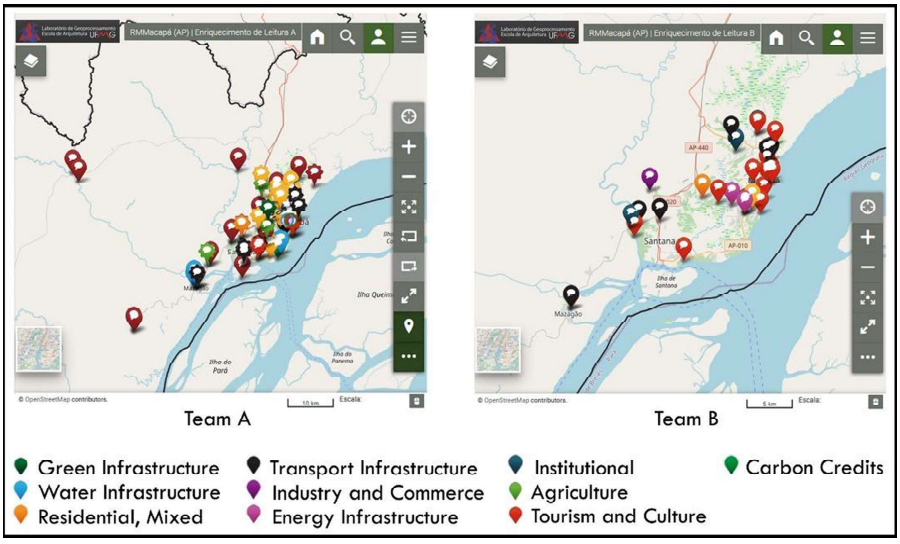

Fig. 7. Results from the first day of the workshop.

3.2 Day 2 – Creation of Proposals – Without Innovations, "Non-Adopter"

Following the methodological procedure proposed by the IGC and adopted by the international groups, the second session aimed to evaluate the scenarios that would be produced when applying traditional planning, without innovative interventions on the territory - a stage defined as the "non-adopter". For the years of 2035 and 2050, planning was to follow traditional political actions, with a future scenario designed according to Brazil's reality and resulting from traditional planning paradigms already used in the country's territorial planning.

This stage started with participants reading the notes that were created in the previous encounter, by both groups, followed by spatial identification. Afterwards, they received an explanation regarding the necessary procedures for building their proposals within the platform. The proposals were created based on three basic geometric shapes: points, lines, closed polylines and polygons. The designs followed the standard colors for each system, defined by the IGC's research team. Proposals regarding carbon credit were only allowed to use polygons, the other systems used open and closed polylines, to avoid the visual complexity of overlapping polygons.

Participants would check the sets of layers per system, use overlaps and transparencies between them, pick the themes they deemed most important for collective analysis and then design their ideas. The location of the proposals would result from this spatial analysis, but also based on the oral contributions by participants, who would add more information based on their expert knowledge. The debates were quite good and served as supports for the decisions.

3.3 Day 3 – Creation of Proposals with Some Innovations, "Late-Adopter"

The third session proposed a new scenario, where MMA would implement proposals that had some degree of innovation - the stage referred to the "late-adopter". Therefore, participants were encouraged to create proposals with relevant impact on the territory, for each of the ten systems. The approach used by each group would be guided by different perspectives: "group A" would build proposals for the year of 2035 using reading enrichment and the notes developed by the group during the earlier stages; "group B", on the other hand, would use the "2035 with no innovations" scenario created by "group A" as their reference, and try to come up with proposals with some innovation for the year of 2050.

The goal of this dynamic was to simulate the period between 2035 and 2050 and evaluate which changes the territory would undergo in terms of planning with innovations. Hopefully, it would be possible to compare two scenarios: Starting from a current reality (2021), it would reach the year 2035 using traditional planning and, from then until 2050, the proposal would start adopting more innovative ideas, but at a moderate pace and restricting those that were not suited for implementation in under fifteen years.

Their ideas were drawn according to the same, previous, dynamic, using points, lines, closed polylines and polygons, with standardized colors per system. Once again, polygons were only used to represent proposals related to the "carbon credit" system.

Aside from debating proposals using each participant's knowledge of the territory, they were also presented with access to a preexisting database with ideas provided by

the IGC website and named "*Assumptions*"[3]. These ideas could be used by participants if they were deemed feasible for implementation in the MMA. The proposals that were adopted would be highlighted so that they could be referenced back to the database using the same code presented on the website.

3.4 Day 4 – Creation of Proposal with Many Innovations and Voting, "Early-Adopter"

The last session had the goal of creating a scenario in which both groups would build plans with several innovations, which would have a major impact on the territory if they were implemented - the "early-adopter". The "Assumptions" database was used once more to aid participants in the creation of their proposals, as well as the same representation scheme.

Before finishing their proposals for the creation, conservation and expansion of areas with robust vegetation to contribute to carbon sequestering, groups were able to use a platform plug-in that would show the percentage of the area necessary to achieve a minimum value defined by carbon credit directives (30% of the MMA).

At last, the final two stages were dedicated to commenting and voting. Participants in "group A" would discuss the context and scenario provided by "group B", and "group B" would do the same based on the work provided by "group A". The goal of this was to consolidate the ideas that were most well-structured, using the questions made in comments, although participants expressed that there was little time available for the task.

After reading the proposals and the comments for each proposal, participants would then vote on them. This stage was also conducted within GisColab and, in each proposal, participants from the evaluating group had the chance to issue a positive or negative vote through the "like" and "don't like" resources. They could also annex, if deemed necessary, comments regarding the proposals in the form of warnings, or suggesting spatial-technical modifications as a requisite for approving the proposal. The voting was individual, and each participant had the right to cast one vote per proposal.

4 Results

Based on the study conducted, we hereby present our evaluation of the discussions between participants, who presented their stances based on their knowledge of the MMA over the course of these encounters. Most participants had institutional ties to public planning offices. This relates to their knowledge on the subject, acquired from their everyday technical work, which played a fundamental role in the decision-making processes. Yet, when questioned on their knowledge of the main characteristics of the MMA, 41% replied that they did not know them, perhaps due to the large territorial extension of the MMA and empty areas that they may have never visited before (see Fig. 8). Over the course of the workshop, it was possible to notice that the cities that form the MMA are not quite connected, which likely explains why part of its population has a challenging time with knowing the full scope of the region.

[3] https://www.igc-geodesign.org/global-systems-research.

Regarding the data used, some degree of appropriation by participants was noted when they faced the need for additional spatial information, so they uploaded it themselves (a process that was facilitated by the platform's interface, which supports alternative information sources). Regarding the available spatial information, the less relevant data, or that were least considered in the "reading enrichment" stage were those regarding "airfields", "insolation per aspect", "youth percentage" and "ducts".

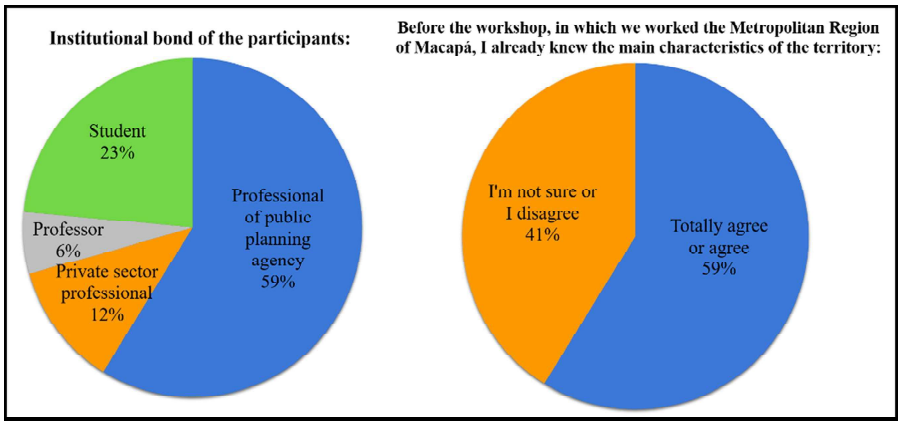

Fig. 8. Charts used for analyzing participants' profiles.

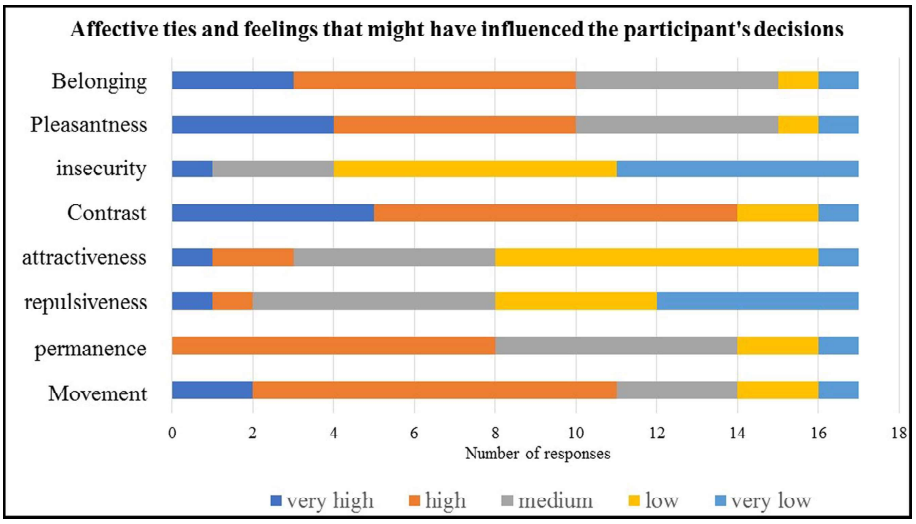

Fig. 9. Charts analyzing the emotional links and feelings experienced by participants.

Regarding the influence of their emotional links to the area, positive or negative, on the decision-making process, participants were asked to express eight possible feelings that they experienced during the workshop (see Fig. 9). According to their replies, it was possible to note participants would experience feelings of significant "contrast" regarding the area. On the other hand, in what touches the realm of belonging and pleasantness, ten participants replied they were "very high" and "high", a fact that is possibly related to their experiences with the local population, and who even work in their own city offices.

Regarding the use of the platform, it was notable that most participants understood the process of geodesign (82%) and there was an increase in the number of people who replied they had knowledge of the method (see Fig. 10). Regarding how easy they considered each stage of the workshop, it is possible to note an increase in those who marked that was quite easy between the first and final stages, which may be explained by: 1) The participants' knowledge of geographical information systems and geospatial software usage in their day-to-day activities; 2) the explanations on how to use the platform; and 3) the presence of mediators in each group and the video explanation on how to use the platform, during the start of each encounter (see Fig. 11).

When asked if they contributed with notes and proposals in each stage of the workshop, it's possible to note a significant amount of them (over 80% in each encounter) made a proposal regarding the area of study and according to the proposed themes. This demonstrates they were able to appropriate the platform during the event, in terms of reading enrichment as well as of proposals made for the metropolitan area (see Fig. 12).

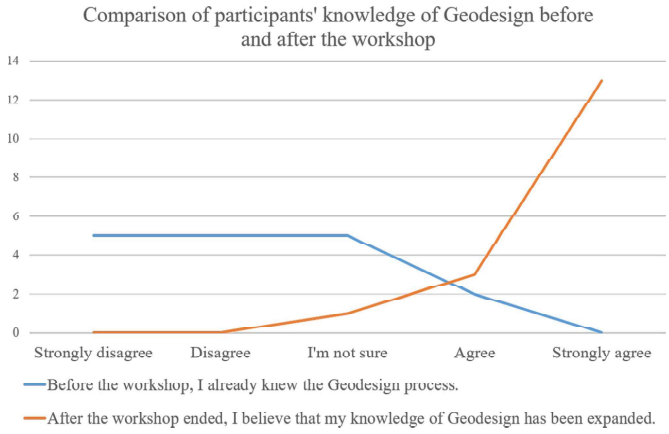

Fig. 10. Charts analyzing participants' comprehension of the Geodesign process.

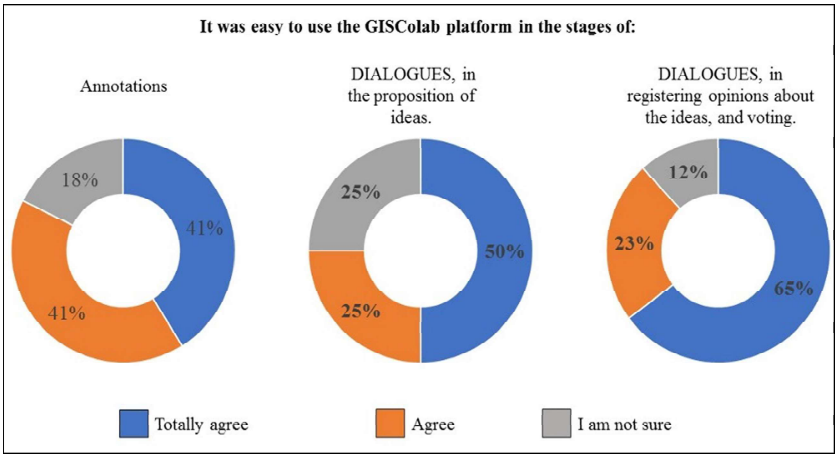

Fig. 11. Charts analyzing their opinions on the use of the platform.

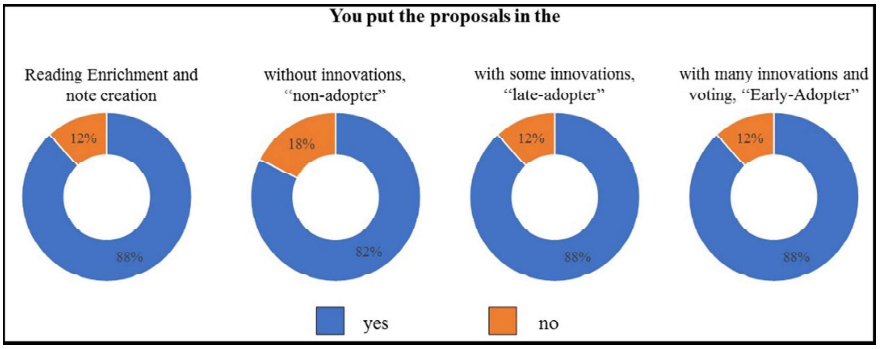

Fig. 12. Charts analyzing the usage of the platform in different stages.

5 Closing Remarks

Since the goal of geodesign is to provide support for populations to make decisions based on a critical understanding of the potentialities and problems of their territories, it is important to stay alert regarding how those involved in these processes deal with spatial representation (the use of a digital platform). The search for a common language and shared assumptions can often be obstructed using complicated digital tools or highly technical discourse with no political consciousness. We should ask ourselves: how can the proposals developed by collective participation surpass the model of just hearings [3], to be part of public policies (which take place in a large period) or projects (implementation/transformation over a shorter period)? This is something to be sought after in processes like the one hereby presented.

Therefore, it is important to pay attention to particularities. For instance, even if the noting stage involves a dynamic that assumes the mapping of specificities, once citizens are invited to speak about their place of use (housing, work) and appropriation, their ideas

tend to remain generic. This is interesting to note, because it reveals how challenging it is to achieve actual, legitimate participation in planning. Another issue we noted is the difficulty in thinking in terms of a Metropolitan Region, and the possibilities for integrating different municipalities. How can geodesign collaborate on integrating the scales?

In the proposition stage it is important to discuss local potentialities. In several moments, talking about issues is more effective. Knowledge regarding the area discussed (through technical data and empirical knowledge by local inhabitants) is essential to think strategically and propose actions that will not only solve something in the area, but also optimize what is considered positive.

Another approach that should be taken is the assessment of the extent to which the proposed future scenarios contribute to the Sustainable Development Goals proposed by the UN for the 2030, Agenda 2015. The Geodesign process can assist in proposing ideas considering the goal of the 17 objectives, and analysis of the results of the case study demonstrated that the proposed scenarios show an increase from Non-Adopter to Early-Adopter, with emphasis on water themes, transport, parks, urban and organic agriculture, but there are few proposals to eradicate poverty. People should be encouraged to think of a better city that also includes the UN Sustainable Development Goals.

At last, it is important to note that the logic of using three different stages (no innovations, some innovation and several innovations), defined by the IGC international group, was not well-received by the group. They had not yet worked in this manner and did not see a lot of sense in stimulating innovations within their local reality because basic issues of everyday life should be solved first to plan for innovations.

During the experiment, they behaved in the same manner they do when performing their daily activities as state workers, who need to fulfill requirements, evaluate the impact and the feasibility of the proposals before registering them, also accounting for the different areas of expertise represented in the workshop. Hence, mediators noted a certain hesitancy in coming up with bolder propositions, particularly when they involved innovations (Late-adopter and Early-adopter), but the overall experience was seen as positive and as a possible way to provide support to opinion-building processes in the public sector, as well as an interesting tool for decision-making.

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