Geodesign Experience in Florianópolis Metropolitan Region: Practical Planning with Different Professional Backgrounds

Francisco Henrique de Oliveira[1(✉)], Julia Cararo Lazaro[1], Ana Clara Mourão Moura[2], Maria Carolina Soares[1], and Guilherme Braghirolli[3]

[1] Universidade do Estado de Santa Catarina (UDESC), Av. Me. Benvenuta, 2007, Florianópolis, Brazil
francisco.oliveira@udesc.br

[2] Universidade Federal de Minas Gerais (UFMG), Rua Paraíba 697, Belo Horizonte, Brazil
anaclara@ufmg.br

[3] Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC), Av. Mauro Ramos, 950, Florianópolis, Brazil

Abstract. The work shows an application of Geodesign for metropolitan region of Florianópolis, at Santa Catarina state, Brazil, with focus on reducing carbon emissions considering the future scenarios of 2035 and 2050. The research took place with students from the discipline of Multipurpose Land Registry and Territorial Planning related to doctoral course of the Post-Graduate Program in Territorial Planning and Social-environmental Development (*Programa de Pós-Graduação em Planejamento Territorial e Desenvolvimento Socioambiental – PPGPLAN*) from the State University of Santa Catarina - UDESC in the year 2021. The students had different training and performances, but all to a greater or lesser degree had experience in urban planning, with 25% knowing the methods and concepts of Geodesign. Due to the conditions of social distancing imposed by the COVID-19 pandemic, the lessons activities took place remotely. Four official weekly meetings and also daily communication were established to carry on the activities, which were performed by WhatsApp, email or even by extra on-line meeting. To assist decision-making on the GISColab Platform, a spreadsheet was created using Excel software that ensured the organization and systematization of proposals, as well as supporting the spatialization of policies and projects. Due to the students' professional experience, the biggest challenge was shown in the proposition of ideas that corroborated with the initial goal, that was especially focused on territorial planning integrated in multifactorial parameters. In this sense, remote meetings fulfilled the role of initiating remote participatory discussion, sharing ideas and decisions for proposals adopted and approved in groups, but revealed the lack of specialized critical thinking, difficulties in developing territorial planning and defending ideas based on action and reaction that GISColab platform provides.

Keywords: Geodesign · Geoprocessing · Territorial planning · Co-creation

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1 Introduction

The article shows the application process of the Geodesign Workshop based on the study area of the Metropolitan Region of Florianópolis, located at Santa Catarina State, in the south of Brazil (which in the study will be called MRSC). The study was part of a national proposal in which 13 researches groups were invited to analyze different metropolitan regions - in which they are partner, using the Geodesign method. The proposal, among others, had the challenge of inciting actions that would help in the maintenance of areas with vegetation, thus collaborating for the creation of carbon credits.

The main objective for this study was to plan the green future area to Florianópolis Region until 2050 - in this case three scenarios was planned. The first one was Scenario A: "Early Adopter" – in which initial innovations were considered, resulting in changes in 2035 and 2050; for Scenario B: "Late Adopter" – in which it was considered wait until 2035, to then adopt innovations that can lead to changes in 2025; and Scenario C: "Non Adopter" – in which no innovation was adopted, allowing for unplanned changes for 2050. Therefore, for this experiment three scenario changes were planned focusing on increasing the Carbon Credit to at least 30% more until 2050 – but clearly it was an obligation to increase the green area surface for the Florianópolis Region. Thus, the basic tool for planning the three future scenarios, as well as discussing, proposing new green áreas and also considering the United Nations Sustainable Development Goals was the Geodesign platform environment.

1.1 Study Area

For the study of MRSC the workshop was applied with the group of students of PhD course related to Postgraduate Program in Territorial Planning and Socioenvironmental Development - PPGPLAN, from the State University of Santa Catarina - UDESC.

The MRSC is one of the main centers of the technological industry (game software) in Brazil, mainly Florianópolis, where tourism, civil construction, commerce and the service sector also stand out. In the neighboring cities, mainly São José, Palhoça and Biguaçu, there is a diversified and growing industrial pole, in addition to important areas of services and business. Beyond that, most municipalities in the expansion area present themselves as important areas for agriculture. As for the relief, the region has a predominant area on coastal plain, which includes the coastal part and the mountainous region, with vegetation from the Atlantic Forest biome and still restinga (sandbank) and mangrove vegetation.

There is a strong contrast between the coastal area totally dense by buildings and real estate exploration, in contrast to the continental area, which has a predominantly rugged relief and has a predominance of tree cover with vegetation exuberance. The studied area is composed of 22 municipalities, but the actual Metropolitan Region of Florianópolis comprises 9 municipalities with a population of 1,050,000 inhabitants living in an area of 2,700 km^2, with the other 13 municipalities belonging to the Metropolitan Expansion Area (Table 1 and Fig. 1).

Notoriously, this is one of the regions with the best life quality level in the country, the Metropolitan Region of Florianópolis has the highest HDI (Human Development Index) of 0.840, among all metropolitan regions in Brazil [2].

Table 1. Municipalities from RMSC [1].

Municipalities of the Metropolitan Region of Greater Florianópolis	Águas Mornas, Antônio Carlos, Biguaçu, Florianópolis, Governador Celso Ramos, Palhoça, Santo Amaro da Imperatriz, São José, São Pedro de Alcântara
Municipalities in the Greater Florianópolis Metropolitan Expansion Area	Alfredo Wagner, Angelina, Anitápolis, Canelinha, Garopaba, Leoberto Leal, Major Gercino, Nova Trento, Paulo Lopes, Rancho Queimado, São Bonifácio, São João Batista, Tijucas



Fig. 1. The Metropolitan Region of Florianópolis (RMSC) in Brazil and other case studies in Brazil, and the municipalities of MRSC. Source: the authors.

When analyzing the set of maps on the study area, it is initially necessary to observe that the area is composed of a large island (54 km of length and 18 km width), in the municipality of Florianópolis, capital of the state of Santa Catarina, and by a significant urbanized area on the continent, corresponding to the connection with the island (Fig. 2 - d). However, in the rest of the region there is low occupation and significant vegetation cover, composed of Atlantic Forest (Fig. 2 - f).

The surface temperature has a greater impact in the central area of the island and in urban area of the continent in connection with the island, being mild in the regions of higher altitude (east–west axis to the south of the continent) and in unoccupied valleys (Fig. 2 - a). The topography is composed of the low altimetry on the island and the portion of the continent close to the island, with an east–west mountain range in the south of the continent (Fig. 2 – b). The slopes are low and favorable to use, but with the challenges of containing the risks of flooding on the edge of the island's mainland,

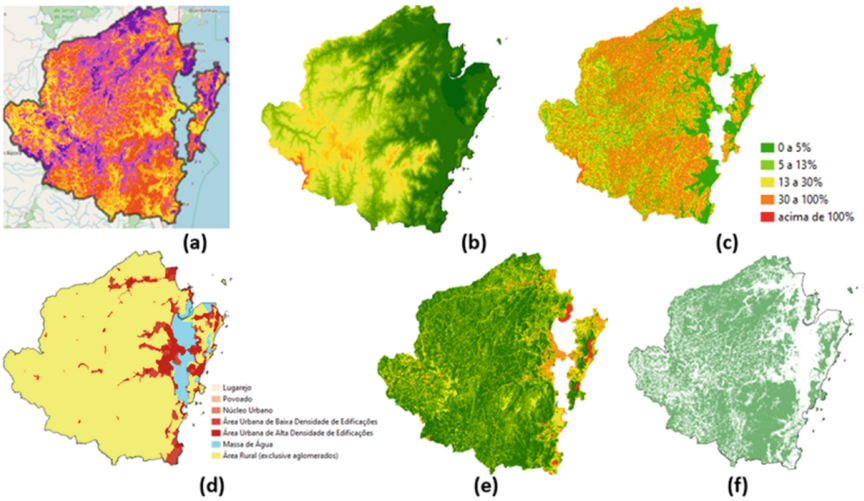


Fig. 2. Surface temperature (a), altimetry (b), slope (c), urban land use (d), NDVI (e) and vegetation cover (f). Source: the authors.

but the difficulty of urban expansion in much of the territory is observed due to the high slopes (Fig. 2 - c).

Regarding the vegetation index, the NDVI (Normalized Difference Vegetation Cover) indicates the absence of vegetation in the large lagoons and the low presence in the urbanized area of the continent that connects with the island, but in the rest the vegetation is expressive and robust, which highlights the RMSC from the other studied metropolitan areas (Fig. 2 - e). In summary, it is an area whose urban occupation is concentrated and dense in the relationship between island and mainland, with more impact on the mainland portion, but with a wide area of expressive vegetation cover, of difficult urban occupation due to slope barriers.

The distribution of commerce and service activities (Fig. 3 - a) demonstrate the importance of the mainland area connected to the island (Biguaçu, Palhoça and São José), and the same can be seen in the health services map (Fig. 3 - b), accessibility and capillarity (Fig. 3 - c). It is observed that the density of roads, in the accessibility and capillarity map, is even more expressive in this portion of the continent than on the island (Fig. 3 - c). As observed in the previous cartographic collection, the remainder is a large void, except for the axis that connects Canelinha to São João Batista and Nova Trento (north portion) and the Palhoça axis to Santo Amaro da Imperatriz (central portion). In this sense, the planning needs to consider the densification in the areas of the island's connection with the mainland and in these incipient axes of growth.

It is worth mentioning the fragility in the supply of sanitation, with the presence of water network only in the mentioned areas (Fig. 3 - d) and many limitations in the sewage network (Fig. 3 - e). It is worth noting the importance of the island area in terms of the presence of cultural and archaeological heritage, as well as the presence of indigenous land in the mainland area. (Fig. 3 - f).

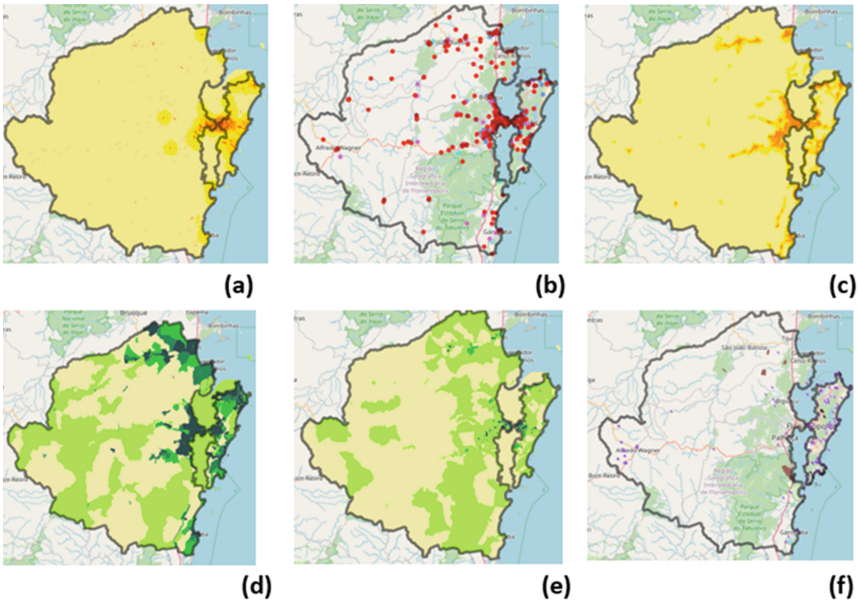


Fig. 3. Commerce and services (a), health services (b), accessibility and capillarity (c), water services (d), sanitation (e) and cultural and archeological heritage (f). Source: the authors.

The development of the study had two purposes: a) to enable the participating students to carry out a geodesign study, while expanding their knowledge about the territory of the RMSC; b) collaborate with studies on a national scale on 13 metropolitan regions in Brazil, by verifying the reproducibility of the geodesign methodological process.

1.2 Geodesign

The Project that planned the study of Brazilian metropolitan regions, was entitled: "Geodesign Brazil, Trees for Metropolitan Regions". The idea was to use the Geodesign method in a standard, simultaneous format that would allow the application in different scenarios but with a standard in the type of data used as well as in the applied methodology.

Geodesign is a methodological process that explores the potential of geospatial technologies, Geographic Information Systems and their web-based resources, for co-creation processes in shared planning. Its structure is a work framework that starts with the consumption of data, which are translated into information and generate knowledge about the area of study. As it has a geographical base, it explores geovisualization resources and access to different actors in society, so that participatory planning actually takes place [3–8].

The basis of Geodesign is the proposition of a work framework, in which steps and objectives to be accomplished, actors and teams of participants, decision support, goals to be met, negotiation and results evaluation methods are specified. In the case study

in question, the script initially proposed by the IGC (International Geodesign Collaboration) and its adaptation to Brazilian case studies was followed, using the GISColab (UFMG) platform and using the same initial list of maps and characterization data of the study areas [14, 15]. However, due to local differences, each group was free to adapt the processes to their specific objectives.

In the RMSC case study, the adaptation took place due to the composition of the participants. As the workshop had as actors the postgraduate students in Territorial Planning and Social and Environmental Development, not all participants had skills and practice in the use of Geographic Information Systems. It can even be said that many of the participants did not feel comfortable working with geographic information as a first reference. In this sense, the main adaptation to the method was the brainstorm process of co-creation of ideas, elaborated in the form of a table of alphanumeric proposals that, not necessarily, emerged from map information, but were translated in the second moment to the geographic location. It is an adaptation contribution on ways of working considering participants from professional areas who do not necessarily have knowledge and skills of geographic spatial analysis.

2 Methodology

Brazil is a country of continental dimensions and of big differences in spatial, social and economic conditions. Carrying out urban planning in such complexity requires adaptability and scalability conditions, as the regions will have different conditions of participation and resources. Starting with digital inclusion and access to technological resources, there are great disparities. It was the intention of the group of Brazilian universities linked to the IGC (International Geodesign Collaboration - https://www.igc-geodesign.org/) to carry out a study together, but at the same time with freedom for the necessary adaptations due to local specificities. The 13 studies carried out presented variation in the form of development (asynchronous and synchronous), of the actors involved (undergraduate, graduate students, planning professionals of university researchers), access to additional tools (application development and specific and additional methodological procedures), in the time available for the experiment (in more concentrated processes or with more time between stages). Even with the local differences, it was possible to follow a common script and, at the same time, record and measure the adaptability condition to contemplate each local need [9–21].

All followed the schedule proposed by the IGC to consider the scenarios for the year 2021, 2035 and 2050, in view of the global climate agreements and the Sustainable Development Goals [13]. And to act according to different planning patterns, related to traditional processes, which do not adopt innovations at first and then accept them, or those that are innovative from the beginning. With this temporal scale of behavior variation, proposed by the IGC, the expectation would be to expand the capacity for innovation and, mainly, the measurement of gains in meeting the goals of sustainable development (SDG) (Fig. 4).

Also as proposed by the IGC, participants had access to a list of assumptions, a set of best practices on the different planning systems, as a way of encouraging the use of innovations. The systems proposed for all participants were: water, energy, vegetation,



Fig. 4. Sustainable development goals [10].

institutions, agriculture, transport, housing and mixed use, commerce and industry. In the opinion of the organizers, two other systems could be added, and the Brazilian group chose to include tourism and culture and to include a specific system to propose and measure contributions to the Carbon Credit (Fig. 5).

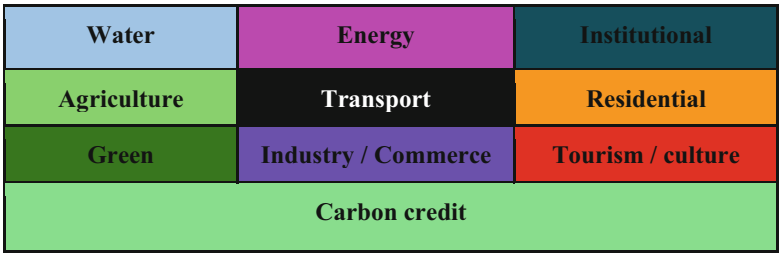


Fig. 5. Workshop themes. Source: authors (2021).

All Brazilian projects received the same collection of representation maps and processes (data and information on the spatialization of occurrences and their areas of influence) and the use of the Brazilian Geodesign platform, GISColab [11, 12, 19]. The EA-UFMG Geoprocessing Laboratory was responsible for assembling a collection of around 40 maps for each of the metropolitan regions involved. With this, it was possible to measure the scalability of the process of setting up a workshop, in terms of time and access to a minimum set of information. Free access data, made available on a spatial data infrastructure platform or satellite imagery, were used. The time spent on producing the maps was measured and it was observed that in order to set up a case study on a regional scale, in Brazil, a week of work would be necessary, even for regions with fewer resources [9].

It would be possible to assemble a much more robust data collection for the island of Florianópolis, but not exactly for the entire metropolitan region. In order to apply the same conditions for the entire country, the quality and resolution cut to a regional

scale was carried out, as a first approach, without prejudice to the development of future studies in greater detail.

For visualization of geospatial data layers and spatialization of proposals, the GISColab platform was adopted [16]. GISColab is based on the SDI (Spatial Data Information) and OGC standards for data consumption via WMS or WFS, allowing both cases to increase performance by WPS (Web Processing Service). For training in the software navigation, the groups had videos recorded by Professor Ana Clara Mourão Moura and assistance from the monitors: Beatriz Fernandes and Thiago Lima. In use, adaptations were made to the process, demonstrating the flexibility of both the method and platform.

For standardization in the analysis proposed in the workshops, all groups had as main objectives:

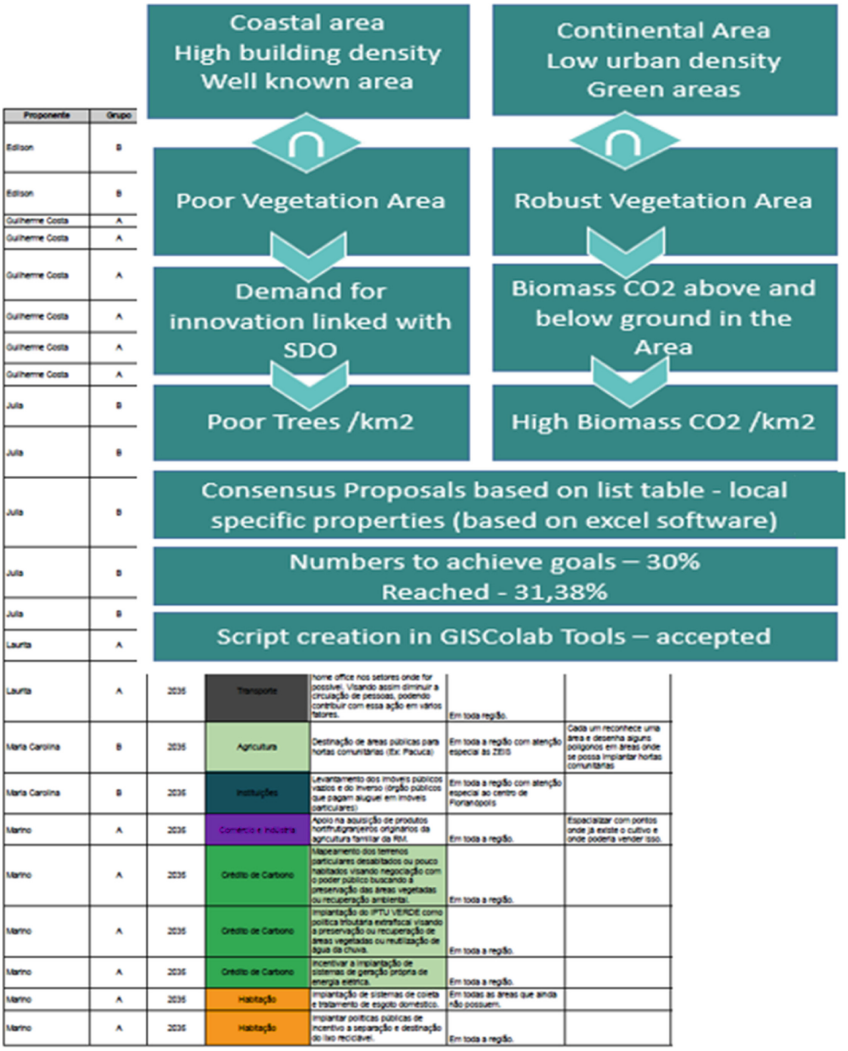
- Increase the area of robust vegetation by 30% by 2050, as a contribution to carbon credits;
- Contemplate the 10 pre-determined systems (or themes) for carrying out the actions, prioritizing projects that were associated with carbon credit;
- For all possible actions, consider the 17 Sustainable Development Goals (SDGs) of the Global Compact, a UN initiative.

For the MRSC, the following specific objectives were listed:

- Informing places of conflicts of environmental interest and real estate exploitation;
- Implementing Conservation Units in areas of dense vegetation;
- Improve mobility;
- Consider sustainable technologies for civil construction;
- Deploy renewable energy sources - mainly solar energy;
- Implement a sewage treatment system;
- Improve tourism activities with a focus on ecological tourism;
- Implement policies to protect areas of the marine coastline;
- Extend the protection of springs and hill tops.

The main goals and framework developed is presented in Fig. 6. The area was divided in two: the coastal area and the continental area, according to the conditions of poor vegetation and robust vegetation. The goals were to consider the SDGs and the increasement of carbon sequestration. The consensus about the proposals were constructed using alphanumeric tables, presenting the list of ideas, the description of each of them, their relation with the main systems, the year of reference, and the place indicated for them. The column of place initially was a generic description that, with the development of the workshop, was transformed into polygons (Fig. 6).

The chronology of the activities followed the general indications of the project but with adaptations to the profile of the workshop participants. The meetings took place for 4 weeks, once a week, in the online format and the contact between the participants was carried out daily with an instant messaging application. A total of 9 students from the discipline of Multipurpose Land Registry and Territorial Planning from PPGPLAN/UDESC participated. In summary, the actions taken were as follows:



Proponente	Grupo					
Edison	B					
Edison	B					
Guilherme Costa	A					
Guilherme Costa	A					
Guilherme Costa	A					
Guilherme Costa	A					
Guilherme Costa	A					
Guilherme Costa	A					
Julia	B					
Julia	B					
Julia	B					
Julia	B					
Julia	B					
Laurita	A					
Laurita	A	2035	Transporte	home office nos setores onde for possível. Visando assim diminuir a circulação de pessoas, podendo contribuir com essa ação em vários fatores.	Em toda região.	
Maria Carolina	B	2035	Agricultura	Destinação de áreas públicas para hortas comunitárias (Ex: Pacuca)	Em toda a região com atenção especial às ZEIS	Cada um reconhece uma área e desenha alguns polígonos em áreas onde se possa implantar hortas comunitárias
Maria Carolina	B	2035	Instituições	Levantamento dos imóveis públicos vazios e do inverso (órgão públicos que pagam aluguel em imóveis particulares)	Em toda a região com atenção especial ao centro de Florianópolis	
Marino	A	2035	Comércio e Indústria	Apoio na aquisição de produtos hortifrutigranjeiros originários da agricultura familiar da RM.	Em toda a região.	Espacializar com pontos onde já existe o cultivo e onde poderia vender isso
Marino	A	2035	Crédito de Carbono	Mapeamento dos terrenos particulares desabitados ou pouco habitados visando negociação com o poder público buscando a preservação das áreas vegetadas ou recuperação ambiental.	Em toda a região.	
Marino	A	2035	Crédito de Carbono	Implantação do IPTU VERDE como política tributária extrafiscal visando a preservação ou recuperação de áreas vegetadas ou reutilização de água da chuva.	Em toda a região.	
Marino	A	2035	Crédito de Carbono	Incentivar a implantação de sistemas de geração própria de energia elétrica.	Em toda a região.	
Marino	A	2035	Habitação	Implantação de sistemas de coleta e tratamento de esgoto doméstico.	Em todas as áreas que ainda não possuem.	
Marino	A	2035	Habitação	Implantar políticas públicas de incentivo a separação e destinação do lixo reciclavel.	Em toda a região.	

Fig. 6. Decision making process. The background figure (excel table) is a simple illustration to demonstrate that the process started with the decision of ideas by theme, followed by the negotiation on spatialization. Source: the authors (2021).

- Day 1 - Reading enrichment - Indication of potentialities, vulnerabilities, characteristics and needs in the 2020 scenario, by Annotations, using a Web-GIS with 40 maps.
- Day 2 - Construction of Ideas for "Non-Adopter" 2035 and 2050, through the tool Dialogues.
- Day 3 - Construction of ideas for "Late-Adopter" 2035 and 2050, through the Dialogues tool. They had the target to increase of 30% of CCO2 until 2050, using the tool Widgets that calculates the percentage reached, number of trees and the sequestration of CO2 above and below ground. They used the list of Assumptions.
- Day 4 - Construction of ideas for "Early-Adopter" 2035 and 2050, through the "Dialogues" tool. They used Widgets to increase of 30% of CCO2. They used the list of assumptions. Debates through comments and voting on the Dialogues tool.

For the spatialization of the proposals, the GISColab platform was used [17, 18], in which thematic layers of geospatial data such as Conservation units, urban areas, among others, were previously inserted, so that the analysis could deepen according to local characteristics.

The compilation of thematic data took place in a pre-workshop stage in which, in addition to the data collected, basemaps were created for all metropolitan regions, planning of the automated calculation tool for the number of trees, CO^2 and percentages. For better organization, after the first moment of Reading Enrichment, a spreadsheet was created in which all participants collaborated with the proposals, listed by themes, groups and authors. With the spreadsheet ready, discussions and votes were held to maintain or withdraw proposals. It should be noted that the proposals were listed for different scenarios, explained in Fig. 7.

cenario	Description
Early adopter (years of 2035 and 2050)	Proposals should contain more innovations, with more advanced technologies
Late adopter (years of 2035 and 2050)	Proposals with less innovations, with more popular technologies
Non-adopter (year of 2050)	Proposals with little innovation, standard technology

Fig. 7. Workshop scenarios. Source: the authors (2021).

After each discussion, the students spatialized the actions on the maps, through the GISColab platform. Each theme has a standard color, so in all scenarios, regardless of who was editing, it was possible to maintain visual harmony. The proposals were spatialized in pins and vegetation areas to increase carbon credits (polygons in light green) (Fig. 8).

After the elaboration of proposals for the different scenarios, voting, spatialization and confirmation of the achievement of the goal of adding carbon credit, the data from

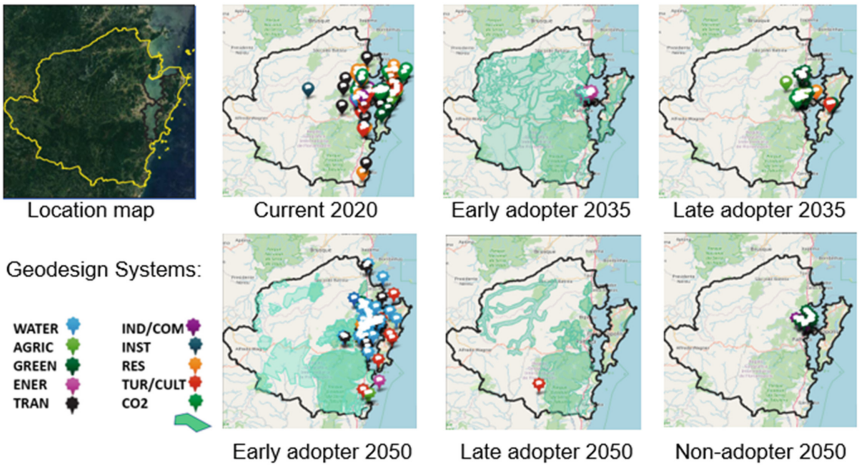


Fig. 8. Maps with proposals on the GISColab platform. Source: GISColab platform. Elaboration: authors (2021).

the GISColab platform were tabulated in two ways: 1. verifying the conformity of the proposals with the Sustainable Development objectives of UN, 2. verification of planned vegetation increase. The data for these steps will be seen in the next item of the study.

3 Discussion of Results

In general, the proposals presented a bias of more traditional technologies although with important bases in the social and environmental questions. The goal in relation to the carbon credit increase was successfully achieved, however there was a low diversity of actions related to the United Nations Sustainable Development Goals (SDG) items. In relation to the SDG, a degree of score ranging from -3 to 3 was listed, being negative when it was a bad proposal for that theme and positive when adding to the theme (Fig. 9). The following information on Fig. 9 is a summary of the actions and the results for each scenario, considering the direct or indirect correlation between each element on the first column (17 SDG) and the first line of the matrix, which describe each one of the 10 themes listed on Fig. 5.

The Fig. 10 illustrates the adherence of the 10 themes developed in the Geodesign dynamics workshop that took place in the discipline, considering the 17 goals of the SDG. The numbering highlighted within the matrix (with shades of purple and orange) refers to the intensity of adhesion (from highest to the lowest level).

Early Adopter: For this scenario, the current situation in 2020 (14) showed flaws in many items of the SDGs, being favorable only in some conditions of Agriculture and Institutions, and with weaknesses related to the other themes. When acting as an Early-Adopter, the score increased a little for 2035 (26) and a lot for 2050 (113), demonstrating that innovations can make a difference in complying with the SDG. Perhaps the group

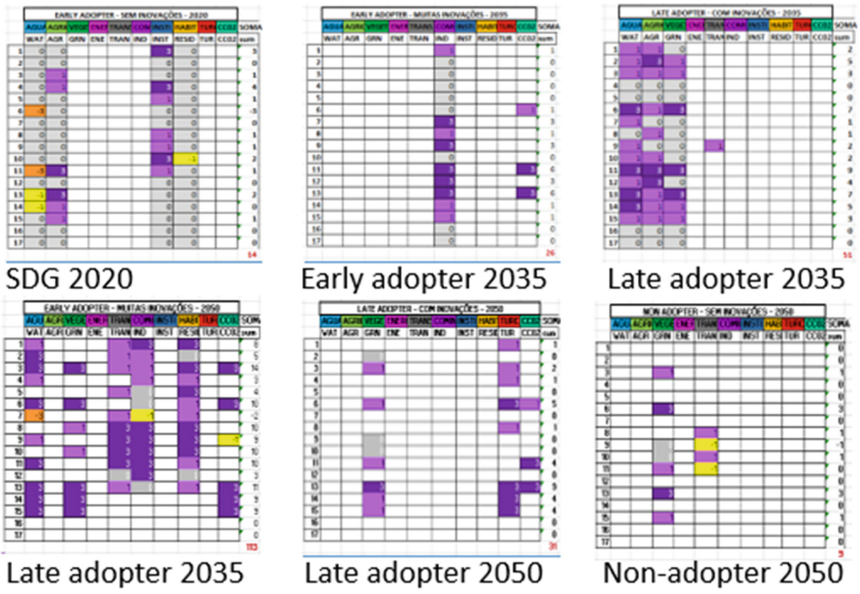


Fig. 9. Tabulation of SDG/ONU proposals in relation to the proposed themes Source: authors (2021).

Most benefit	3	#7030A0
Benefit	1	#CC66FF
Neutral	0	#BFBFBF
Detriment	-1	#FFFF00
Most Detriment	-3	#FF9933

Fig. 10. Scale of correlation SDG/ONU with workshop themes related.

was not prepared to plot all projects and policies on the GISColab platform, sharing their views.

Late Adopter: The Late-Adopter 2035 (51) had a performance far superior to the Non-Adopter 2050 (9), in values. In fact, the group had a little resistance to putting their ideas on GISColab - compiling a large part of the policies and projects in the spreadsheet that should be used as support. In this case, the graphic representation was minimal but the discussions and the main objective were achieved: to increase carbon credit. Regarding the themes, there are improvements in water, agriculture and green.

Non Adopter: It is observed that the Non-Adopter arrives in 2050 with the score (9) slightly below the current scenario (14), because the proposals, although without major innovations, did not consider the future scenario as possibilities for development. It may have been difficult to plan the future with policies and projects - given that part of the group was not used to this type of exercise.

Analyzing the data in relation to the main objective of the workshop, to increase the percentage of green area for carbon credit, it was found that the goal was achieved smoothly by the natural characteristic of the MRSC and also by the profile of the workshop participants, who put environmental actions as a priority.

4 Participants' Report and Conclusion

Throughout the process of applying Geodesign, different profiles of professional background were identified within the participating student's class, so the questionnaire was conducted at the end of the experiment to record individual and group impressions.

Considering that the whole project process took place remotely due to the COVID-19 pandemic and its implications, it was questioned whether they believed that there would be a difference in the result of applying the method if the process were in person, and for almost 70% of the group believed that yes, it would be different. Thus, was majoritary the feeling that being together and discuss face to face is better to convince or expuse the point of view related to any decision.

Regarding the degree of difficulty in carrying out collective decision -making actions, there was a balance in relation to the number of responses from those who found it easy and those who found it difficult, even so, in general the group understood that there was no conflict for decisions since the proposals were created together. But, considering the GeoDesign methodological procedure it is necessary to underline the process of definition and implementation of each proposal in order to get iteration and redefine the common focus.

About the Geodesign methodology, about 60% considered that they fully understood the method and 40% partially - besides, we must consider that for many of the participants was the first contact with the Geodesign methodology and GISColab Platform. Considering that only 3 people in the group had knowledge about Geodesign, it was a very positive margin of result.

Regarding the use of the GISColab platform in general, the group was relatively easy to use, having some ideas for improvements such as the possibility of more than one collaborator editing the map simultaneously, the creation of several polygons within the same proposal, among others. But, for the group to get skills in the GISColab platform it took a bit of time and some hours of training, as well as many messages, recommendations, orientations shared by the group.

Regarding the process as a whole, it can be said that the experiences of applying Geodesign, as well as any collective decision process, will always encompass a very unique character. In addition to what has already been mentioned, another very evident issue is that the more the individual had a connection with the place, the easier the actions could be proposed. Thus, it was noted that the proposals were largely linked to the participants' living and/or leisure places, showing the importance of people getting to know their cities and regions for effective participation in cooperation processes.

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Key software used GISColab - Geoprocessing Laboratory at EA-UFMG & Christian Freitas. Accessed in April and May 2021.

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