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ARTIGO

# PLANNING AND CO-CREATION OF QUADRILATERO FERRIFERO CULTURAL LANDSCAPE: BRAZILIAN GEODESIGN FACING INEQUALITIES IN ACCESS AND USE OF DIGITAL INFORMATION

## *PLANEJAMENTO E COCRIAÇÃO DA PAISAGEM CULTURAL DO QUADRILÁTERO FERRÍFERO: GEODESIGN BRASILEIRO ENFRENTANDO AS DESIGUALDADES DE ACESSO E USO DA INFORMAÇÃO DIGITAL*

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## RESUMO:

Apresenta resultados sobre estudos de Geodesign do Quadrilátero Ferrífero (QF) em desenvolvimento desde 2016, segundo abordagens econômica, ambiental e social, visando favorecer o planejamento da paisagem cultural por processo compartilhado, por suporte à construção de opiniões coletivas e individuais. Tem como objetivo de apresentar a plataforma brasileira de Geodesign, denominada "GISColab", foi testada pela primeira vez no estudo de caso Quadrilátero Ferrífero. A área QF é caracterizada por conflitos de interesses devido às atividades de mineração, crescimento urbano, paisagens de patrimônio cultural e presença de áreas de proteção ambiental. O QF é especialmente importante como parte da estrutura econômica do estado de Minas Gerais (Brasil), mas tornou-se mundialmente conhecido devido a desastres ambientais que causaram a morte de quase 300 pessoas. Nos primeiros estudos foi utilizado o framework de Steinitz (2012), mas diante de observações de dificuldades no processo, foi desenvolvida uma plataforma e roteiros de trabalho mais adaptados às desigualdades de acesso e uso da informação, para que as pessoas realmente se sentissem participantes de todas as etapas. A nova plataforma web é baseada em Infraestrutura de Dados Espaciais (SDI), que recebe uma quantidade considerável de dados e está aberta para receber mais informações via Web Map Service (WMS), garantindo que os usuários construam, por si próprios, julgamentos sobre as áreas em planejamento. Favorece o processo compartilhado de tomada de decisão por diálogos digitais, assim como por votação baseada no Método Delphi. A plataforma e o processo baseiam-se na geovisualização, interoperabilidade e cocriação de ideias com base na geocolaboração.

**PALAVRAS-CHAVE:** Geovisualização; Planejamento Participativo; GISColab; SDI

## ABSTRACT:

The article presents results about Geodesign studies of the Iron Quadrangle (Quadrilátero Ferrífero – QF) that are under development since 2016, based on economic, environmental, and social approaches, with the goal to promote cultural landscape planning based on shared process, giving support to collective and individual opinion making. It has the goal to present the Brazilian Geodesign platform, called "GISColab", that was first tested in QF case study. The QF area is characterized by conflicts of interests due to mining activities, urban growth, cultural heritage landscapes and areas of environmental protection. QF is especially important as part of the economic structure of the state of Minas Gerais (Brazil) but became globally known due to environmental disasters that caused the death of almost 300 people. In the first studies we used Steinitz´s framework (2012), but some difficulties in the process were observed, what led to the proposal of a new platform and framework, more adapted to inequalities related to access and use of information, so that people could really act as participants of all the steps. The new web-platform is based on Spatial Data Infrastructure (SDI), which receives a considerable amount of data and is opened to receive further information via Web Map Service (WMS), which guarantees the users will construct, by themselves, judgments about these areas. It presents a shared process of decision making by digital dialogues, as by voting based on Delphi method. The platform and process are based on geovisualization, interoperability and the co-creation of ideas based on geo-collaboration.

**KEYWORDS:** Geovisualization; Participatory Planning; GISColab; SDI.

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## INTRODUCTION

According to Peuquet and Marble (1990) geoinformation technology underwent the stages of “process-oriented approach”, “application approach” and “toolbox approach”. Some authors believe the main contemporary contribution is the “visualization approach”, which favors citizen participation (MacEachren et al., 2004; Kingston, 2007; Batty, 2007; Abukhater and Walker, 2010; Andrienko et al., 2011). Moura (2015) and Steinitz (2012) argue that, along with visualization, and in order to foster the participation of multiple actors, it is time, more than ever, to invest on methodological frameworks in order to overcome the labyrinth of possibilities.

The evolution of geoinformation technologies as part of spatial planning in different scales and to include different actors can be very powerful if it connects Spatial Data Infrastructure (SDI) with better visualization conditions organized as Web-GIS (Geographic Information Systems operating in the web) with the goal of supporting opinion and decision-making (PP-GIS - Public Participation Geographic Information Systems), and still consider the role of different actors (PSS - Planning Support System).

Spatial Data Infrastructure was proposed in 1993 by the Mapping Sciences Committee of the U.S. National Research Council as a reference of standardization and availability of geographic information. In 2001, the European Commission launched the INSPIRE - Infrastructure for Spatial Information in Europe proposal, which, according to Craglia and Campagna (2009), sought to organize and integrate the planning activities of the European territorial space, regardless of the national limits that comprise it. In Brazil, the idea resulted the Decree No. 6,666 of 11/27/2008, from Federal Government, establishing the INDE – “Infraestrutura Nacional de Dados Espaciais” as a reference to publish, share and produce digital spatial information (Brasil, 2008).

This premise supports the concept of PP-GIS (Public Participatory Geographic Information System), in which the platform is not simply a repository for data, but most importantly, an interface between citizens and institutions, a channel for establishing dialogs aimed at collective constructions. The principle is also known as “Participatory GIS”. “Collaborative GIS”, “Community Integrated GIS” (Sieber, 2006; Balram and Dragicevic, 2006; Elmes et al. 2004), as “Collaborative Spatial Decision Making” (Nyerges and Jankowski, 1997) and as “Geocollaboration” defended by MacEachren et al. (2004). And it´s also based on “Critical GIS” (Elwood, 2006). Related to that, studies about PSS – Planning Support Systems (Geertman and Stillwell, 2009) have the goal to make technology-based solutions useful to planners, not only integrating data and information, but also structuring actors, tasks and processes.

The sum of these intentions leads to Geodesign, which, according to Steinitz (2012), is the possibility of planning with and for Geography. According to Flaxman (2010), it is also: “a design and planning method which tightly couples the creation of a design proposal with impact simulations informed by geographic context".

Steinitz (2012) proposed framework for Geodesign that has already been applied in experiments and territories across the world, dealing with subjects as diverse as community adaptation to climate change and regional transformations (Rivero et al., 2015; Hayek et al., 2016; Eikelboom, T. and Janssen, R, 2017; Wu, Chia-Lung and Chiang, Yi-Chang, 2018), heritage and cultural landscapes (Burgers et al., 2014; Kolen et al., 2014; Chen et al., 2014; Crumley et al., 2017), and other studies in different scales and different research reasons. The itinerary defined by Steinitz (2012) involves six models, which correspond to six questions: (1) How should the context be described? Representation Models. (2) How does the context operate? Process Models. (3) Is the current context working well? Evaluation Models. (4) How might the context be changed? Change Models. (5) What differences might the change causes? Impact Models. (6) How should the context be changed? Decision Models.

We applied Steinitz' framework to 5 thematic workshops about Iron Quadrangle region (QF), using GeodesignHub platform constructed by Ballal (2015), based on the interests about economic, environmental and social interests, with the goal of understanding and contributing to the fostering of the territorial planning of the region. The present article reports result of a 6th workshop developed using the Brazilian platform and the new framework which, from the lessons learned in the 5 previous studies, was adapted to reflect the reality of complex situations, spatial inequalities and inequalities in access and use of digital information.

The QF region has its own particularities as a mineral province. Iron ore is in the higher topographic areas, a result of the resistance of "canga" (outcrops of ferruginous rocks) in the arrangement of mountain tops and by Atlantic Forest (Sontera et al., 2014; Rapine et al., 2002). It´s drainage system contains, within its territory, two of Minas Gerais' most important hydrographic bays, providing approximately 65% of the water consumed in the capital and its neighboring cities.

Mining activities involving the extraction of iron ore are very important to the state, but have also been responsible for two massive environmental disasters in recent years: the rupture of two tailing dams, spreading rejects onto rivers and urban areas, killing 18 people in the city of Mariana, in 2015, and 270 people in the city of Brumadinho, in 2019. In light of what has been presented thus far, it is possible to understand that the QF holds some particular territorial conflicts: protected environments (vegetation and rivers), natural disasters and urban growth, the state's fundamental economic activities regarding iron ore extraction and its industrial chain, cultural and historical values that represent the very essence of the state.

Based on previous experiences studying the area and conducting workshops, it is believed that the adaptation of the framework from within an SDI/Web-GIS platform amplifies workshop participants' ability to communicate and interpret territory, as well as collaborate to achieving consensus thanks to feedback tools and algorithms that support decision-making and consensus building. This is the reason why the new platform is called: "GISColab: WebGis& SDI to Geodesign as co-creation and geo-collaboration". Our main goal was to improve access and use of digital information by the participants, facing local inequalities and giving support to opinion making.

## THE CONTEXT: IRON QUADRANGLE AS AN EMBLEMATIC CASE FOR GEODESIGN

Guided by the view of the mountains in the early XVIII century, pioneers found gold in the Iron Quadrangle region, which resulted in an economic cycle of gold extraction that would continue for two centuries, followed by the development of urban areas and population growth within the territory of Minas Gerais (Ruchkys and Machado, 2013).

In the 1960's, the economic cycle of iron ore extraction - which is strongly associated to the presence of gold - began to take place in Minas Gerais. Iron ore production has been one of the economic foundations of the state's economy ever since and is now responsible for roughly 8% of the state GDP (gross domestic product) and almost 5% of Brazil's GDP. In Minas Gerais, iron extraction within the QF amounts to some 150 million tons a year of an ore that is considered of extraordinary quality.

Although the most relevant cities of the QF bear national and international recognition, their territory and its landscapes remain unknown to most of their local population. The way in which the roads are disposed causes people to move mostly around three main axes, defining people's mental maps, but the inner areas are taken for empty spaces. The geographic delimitation of the QF region in our studies is broader than the geological area that corresponds only to the iron-rich regions but includes the borders of all the cities that are intercepted by the ferruginous formation. The area encompasses 11713km² and 28 municipalities (Fig. 01)

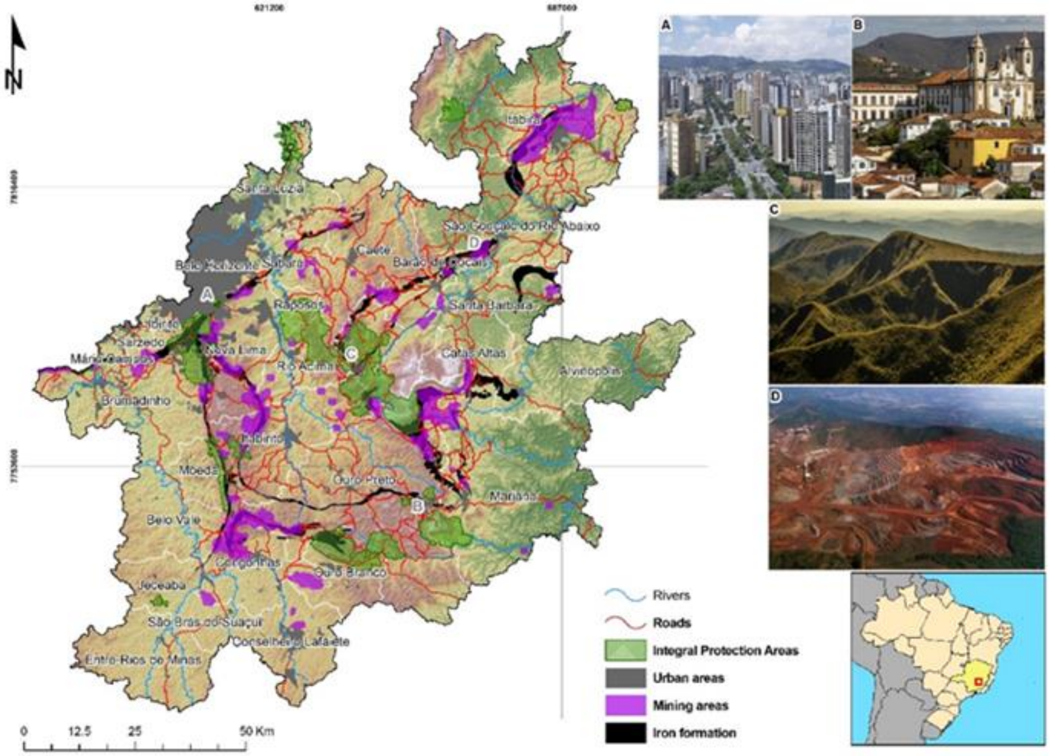



Figure 1. Iron Quadrangle area and landscape

Source: The authors. Pictures from internet sources pbh.gov.br, inforescola.com, vale.com, wikiparques.org.

Because of the complexity of QF land use and landscape, the studies started by promoting 5 thematic workshops dealing with the axis of economy, environment, and social interests. The Economic workshop was held in 2017 and dealt with the following systems: ecology, urban growth, mining and industry, tourism, hydrology, and speleology. All participants were involved with territorial sciences (geographers, geologists, mining engineers, biologists, speleologists, and urban planners), with a strong grasp over the study theme. They all had the same scientific level and were familiar with the Iron Quadrangle area. Perhaps due to the absence of participants who may instill polemic due to very unusual approaches, or perhaps because economic issues are quite straightforward, the workshop was surprisingly swift and consensus was easily achieved, something that was already noticeable when the first projects took place. This was the reason why only a single workshop regarding the economic approach was held (CASAGRANDE & MOURA, 2018).

Two workshops under the Social approach were conducted in 2019. In the first one, the discussions were about the systems: culture, infrastructure, environment, geological risks, economics, landscape, urban growth, and housing. The second workshop focused on the systems: culture, education, housing, sanitation, health, urban growth, economics, transportation, and the environment. It is desirable that systems of different nature are presented, so that participants can decide on various aspects of the reality without losing sight of the thematic approach, in this case the social axis. But we observed that participants were much more interested in environmental proposals, in detriment to the social approach, thus motivating the choice for a second workshop, to led people to pay more attention to social issues.

The first and second workshops with the Environmental approach dealt with the following systems: ecotourism, hydrology, landscape, vegetation, sustainable entrepreneurship, sustainable urban growth. These were conducted in 2019. The environmental theme, regarding the QF, is the clearest in people's imaginary and comprehension, and there were no difficulties in creating proposals and achieving consensus.

As results from the 5 workshops, there were 207 proposals of projects and policies to QF, with different approaches (social, economic and environment), but it was necessary to integrate them in a common shared decision. Besides that, evaluation questionnaires were applied, and the performance of the participants was observed during the workshops.

It was possible to confirm that one of the main problems of the process was the resistance towards Evaluation Models, the third step of the framework. In Steinitz's framework and while using the GeodesignHub platform (Steinitz, 2012, Ballal, 2015), participants have their first contact with information regarding the field of Evaluation Models, which are judgments regarding the best locations to develop proposals (according to vulnerabilities and potentialities, they are classified as "feasible", "suitable", "capable", "inappropriate" or "existing"). In all the workshops, participants criticized the evaluation synthesis because they understood it as a black box and expressed a preference for receiving more information and decide, by themselves, what were the optimal areas (Fig.02).

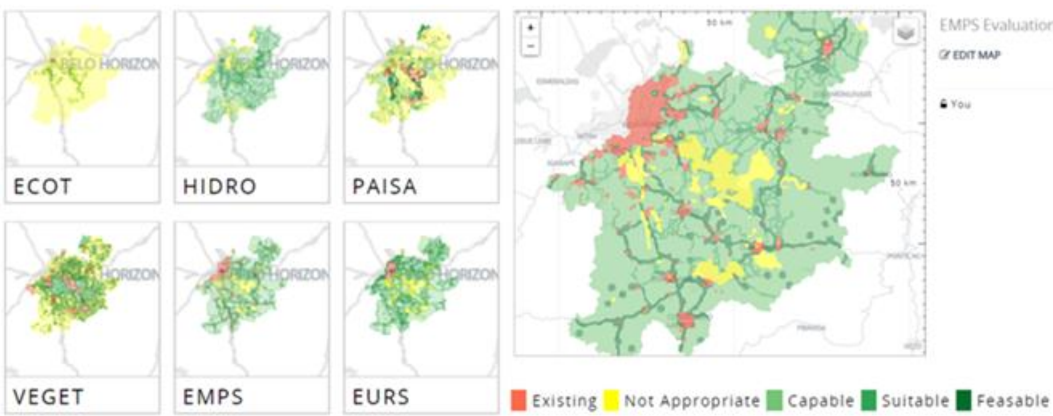



**Figure 2.** Evaluation Models in GeodesignHub

**Source:** The authors.

At that point, it was understood that cultural differences in virtue of our complex reality required us to structure a new framework and platform in order to experiment with different forms of co-creation and geo-collaboration, using flexibility as a requirement present in all stages and, mainly, facing inequalities in understanding the territory, inequalities about the access and the use of digital information. The platform elaborated was based on the concepts of Web-GIS, SDI (Spatial Data Infrastructure) and Geodesign, and the final case study workshop on the QF was organized according to this new work form.

## THE PROPOSAL: A NEW MODEL APPROACH TO GEODESIGN FRAMEWORK

The new platform, GISColab, amplifies access to information thanks to the association with an SDI structure and the principles of interoperability. This means participants already have access to a wide collection of maps but can also access new data via web, and bring them into the context of their studies, as well register new complementary data. It does not limit information to an evaluation map regarding where to draw propositions, but rather extends the possible choices. Another relevant contribution are the scripts for partial and final analysis of propositions, which can be incorporated into the selection and negotiation processes, and coordinators can incorporate new algorithms that are programmed in ETL (Extract Transform and Load) to be used according to the particularities of each individual workshop. Changes in the work dynamic addressed the Brazilian expectation for case studies that are complex and characterized by spatial inequality, or which demand better conditions of engagement, more information, more decision-making support and, most importantly, more dialog (Fig. 03).

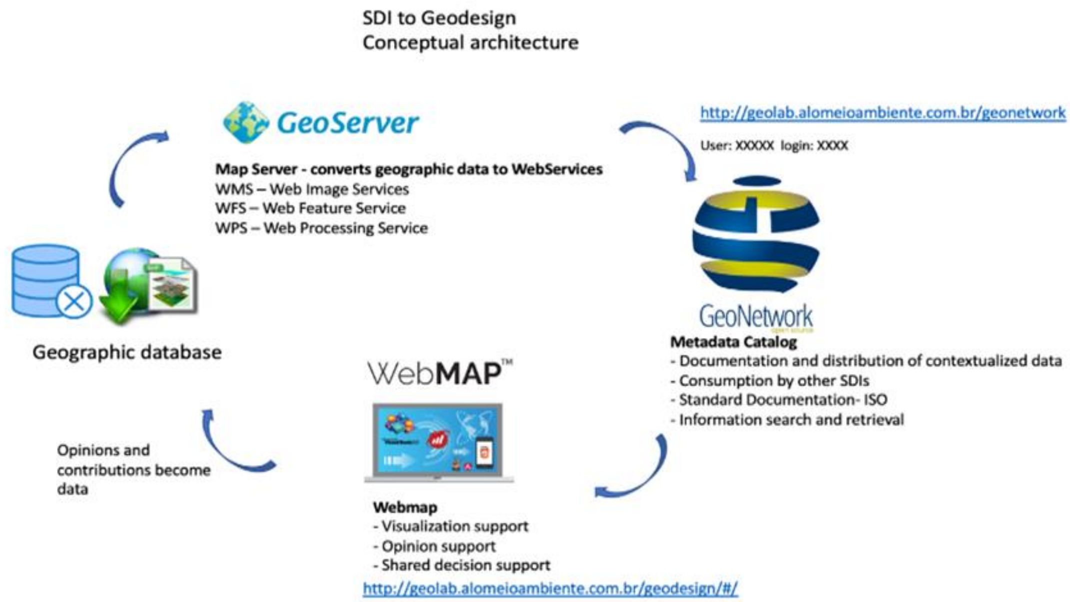



Figure 3. The conceptual architecture of SDI to Geodesign

Source: The authors.

Another difference can be found on how the work systems were structured. In GeodesignHub, they are associated with Evaluation Models and are analyses based on the main variables. They are treated independently, in columns, and bear no relationship among themselves (e.g. The Green Infrastructure, Grey Infrastructure, Blue Infrastructure, Housing systems are all conceived separately). In the Brazilian proposal, instead of working with delimited sets of variables, we define “values” composed of variables and that are characterized as “Contexts”. This means that a single variable may appear in more than one context, if it is deemed important to approach a value that will be subjected to collective planning.

In QF case study the process went through 4 stages, starting from SDI and Web-GIS structures. The stages were enriching participants’ reading experience, brainstorming, discussion and voting, statistics, and final decision. (Fig. 04).

During the process, scripts based on ETL were also used to facilitate processes. Some examples of ETLs that were created and used include those relative to voting statistics and studies on polygon similarity (topological, geographical, conceptual, or taxonomic). However, ones that aim to amplify visualization (word clouds, highlighting key keywords used in dialogs, among others) can also be used and further developed.

The following tools were implemented on the “GISColab: WebGis& SDI platform to Geodesign as co-creation and geo-collaboration”, to foster individual judgments followed by collective appreciation and decision-making based on consensus building.

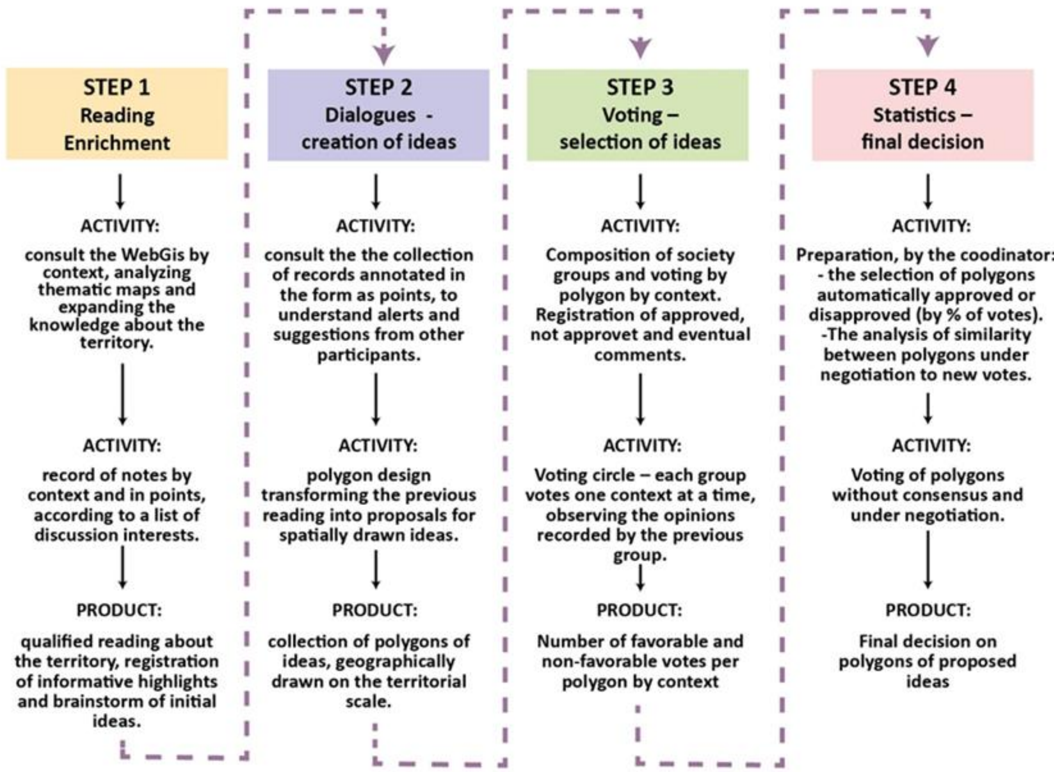



**Figure 4.** Stages in proposed framework

**Source:** The authors.

## SPATIAL DATA INFRASTRUCTURE AS A TOOL FOR GEODESIGN

The SDI was composed of 49 initial maps regarding the key components of the QF area, organized in 24 themes and in 4 main axes of investigation. The guiding principle was that instead of just presenting Evaluation Models, all the necessary information required for a previous understanding of the area was provided beforehand. The 49 layers of information were available for each participant, along with a combination of them, divided in thematic groups. Moreover, it was also planned that an information layer selected from the metadata or found in external data sets available through a WMS (web map service) link, could be used by participants directly from the original platform. In that sense, all data that is available in any other platform can be incorporated by the user, since our platform was designed to act as an SDI itself.

We understand that the ability to search and incorporate new information is more readily understood by people with prior knowledge of GIS, but what happened during experiments with the new platform is that participants would ask for specific data that was unavailable and, with the help of a coordinator, they were taught how to add an additional SDI layer, which turned access to data into a sort of on-demand process.

The participants were supposed to selected or to propose ideas to QF based on the Contexts of Production, Culture, Environment and Housing. Since the idea was to build a final decision from the partial decisions produced in previous workshops, we loaded the 209 polygons and the 49 thematic maps distributed in the contexts:

A) Production - with the goal of discussing the economic production and possible development and entrepreneurial projects on QF, from mining to housing activities, from local production to new economic possibilities.

B) Culture - with the goal of mapping occurrences of cultural significance, within urban or environmental landscapes, as well as possibilities to develop it in QF.

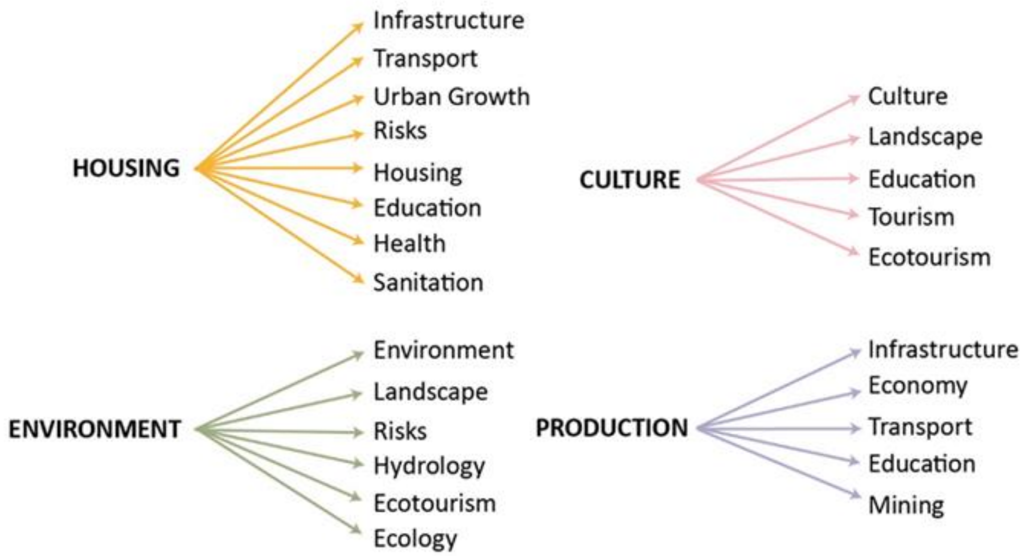
C) Environment - with the goal of mapping existing resources regarding vegetation cover and water resources, as well as areas protected by law.

D) Housing - to characterize current human occupation according their types, infrastructure, connections, new areas of occupation, risks to occupation, income, presence of basic services, among others.

As a Contexts is more than a simple variable, some groups of maps were inserted in more than one context. For instance: information regarding infrastructure or transport may be important for housing or production development, so it must be presented in both contexts (Fig. 05).

**Figure 5.** The organization of themes and main axis

**Source:** The authors.

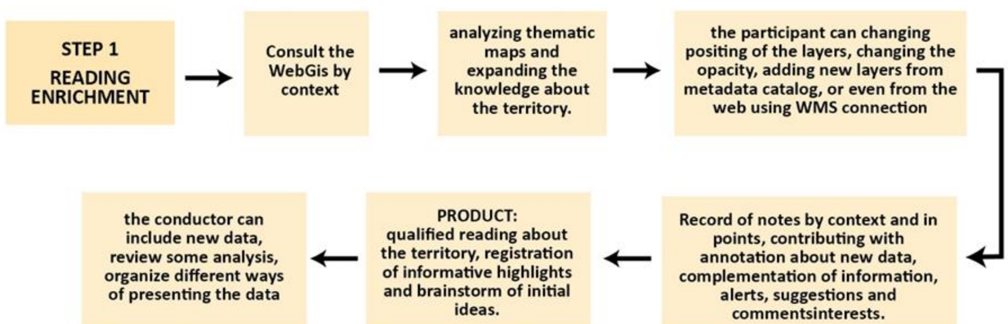



## ENRICHING THE READING EXPERIENCE

From the observation of previous experiences, it was understood that, regardless of all the efforts to provide a complex and complete collection of data regarding a location, there will always be something that was not represented or not fully comprehended. And even when the theme is presented to participants, there are different interpretations and extra information to be included, especially when the approach is related to values in Contexts, and not only within the notion of systems. With that in mind, the first stage of the structure is to "Enrich the Reading Experience" (Fig. 06).

**Figure 6.** Step 1 - Enriching the Reading Experience

**Source:** The authors.



The idea is for the participant to access the Contexts and read the organized data. By reading the data, the participant can learn more about the specific space by using geovisualization tools: change layer positions, change opacity, add new layers from the metadata catalog or even incorporate Web data using a WMS connection. The goal is to provide sufficient resources for the participant to produce their own interpretation, instead of being guided by the point of view of the one conducting them.

Besides, the participant collaborates with information that are not yet available in the platform, with remarks regarding new data, by complementing existing information, by setting alerts or making suggestions and commentaries. These contributions are georeferenced per participant in the shape of location pins, which vary according to a list of interests or themes, to facilitate the visual addition of inputs regarding a same subject (Fig. 07). Layers with remarks and notes end up being a sort of brainstorm regarding how to characterize the area.

**Figure 7.** Enriching the Reading Experience Pins with notes

**Source:** The authors.

The analysis of this initial step allows for the inclusion of new data, analysis review and new forms of organizing the way in which information are presented. As participants enrich their reading experience, they can visualize other people's notes and prepare themselves for the next stage, which is the proposal of ideas.

## DIALOGUE – GENERATING IDEAS

The participant draws his or her idea into one of the Contexts through the "Dialog" interface. They can use any layer of support they wish to decide "where" they will propose "what". It is worth noting that, if a participant is not previously familiar with the territory or is not able to sufficiently increase their knowledge during the Enriching Reading Experience stage, they will likely not feel comfortable drawing a polygon, since the way in which contributions take place requires them to have a structured thought-process and also adopt a position on the matter (Fig. 08).

The way to execute this stage is to read the notes made on step 1 and understand what people are suggesting or drawing attention to. Afterwards, the ideas are drawn as polygons, with suggestive names and descriptions. However, if the case study already has a collection of ideas (existing polygons) - which was the case here -, the participant evaluates them and decides if it is necessary to draw a new proposal, and is free to do so if they wish (Fig. 09).

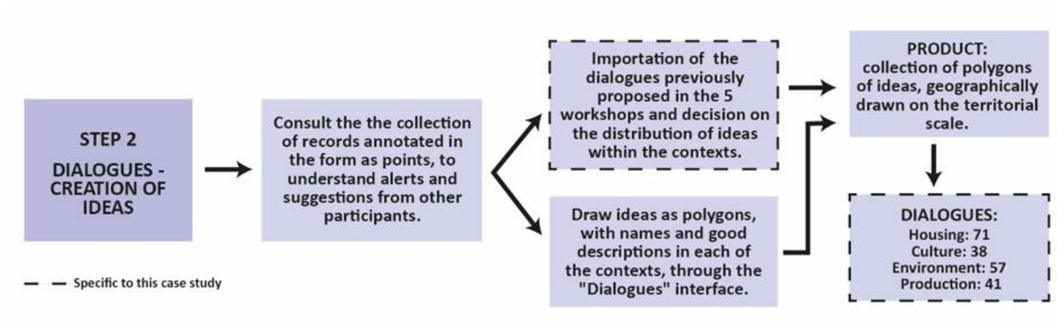



**Figure 8.** Step 2 – Dialogues – Generating ideas

**Source:** The authors.

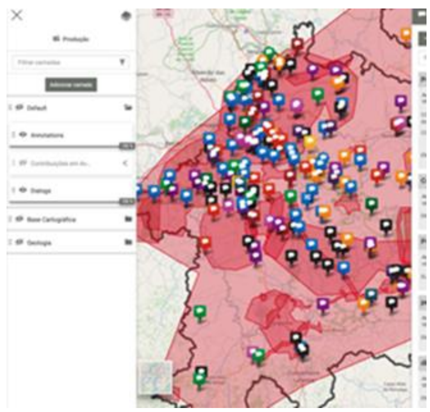


**Figure 9.** Reading the notes from the first step and analyzing the polygons of proposed ideas, or even drawing new idea polygons

**Source:** The authors.

## DIALOGUE – DISCUSSING AND VOTING

Still regarding the "Dialogs" tool, participants are asked to write comments about the ideas that were proposed by others. They can collaborate with new information that supports the idea, present technical arguments to counter the idea, ask questions that will be replied by the author or add any other commentary that may constitute a "Dialog" (Fig. 10).

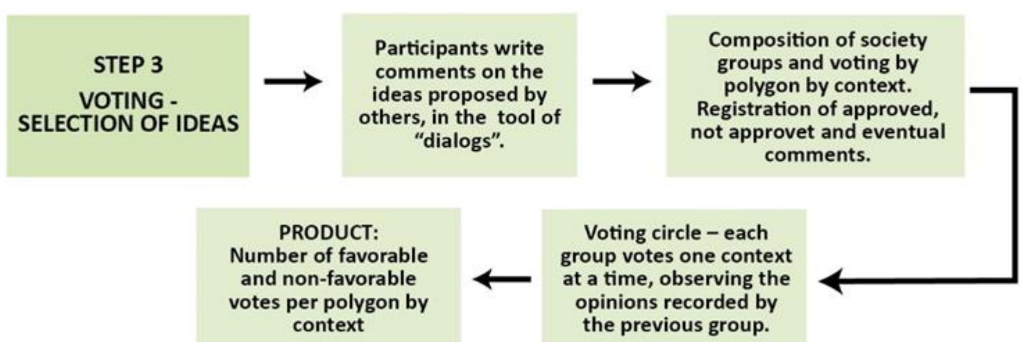



**Figure 10.** Step 3 - Dialogue – Discussing and voting

**Source:** The authors.

Participants were free to comment on anything they wished, but, surprisingly, 92% of participants wrote comments on more than 70% of the polygons. The average comment on the polygons was around 8 and 15 entries for every 25 participants, which means there was a real interest in evaluating ideas and taking part in the debates. The quality of the discussion was particularly good, and this helped participants in voting on whether they approved of an idea or not. That is, because aside from commenting on ideas, each participant was required to vote if they are in favor or not in favor of an idea ("like" and "don't like") (Fig. 11).

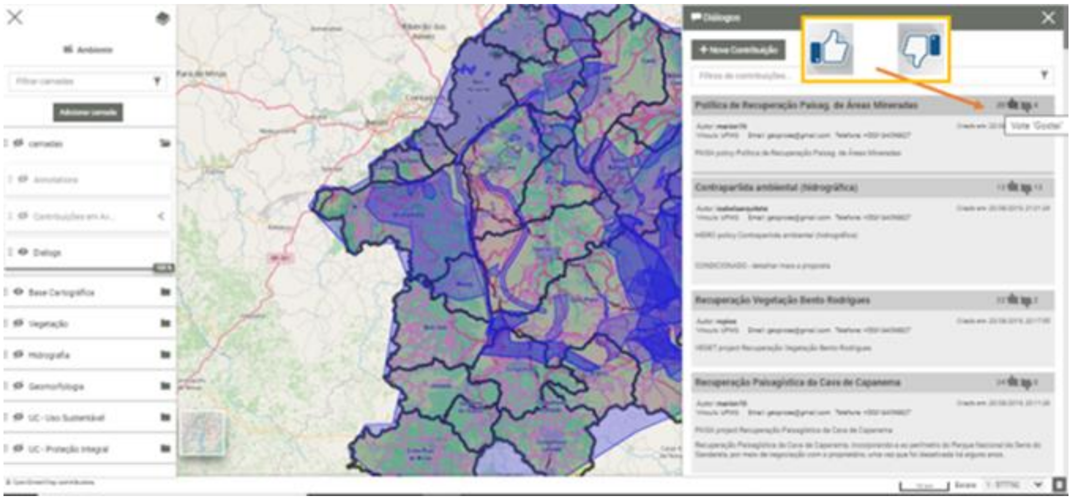


**Figure 11.** The list of comments on each idea polygon and the voting process, selecting "like" or "don't like"

**Source:** The authors.

The stage where comments were written and the voting was done took place in a circle, with each group evaluating thematic axes according to other groups' areas of expertise. People were divided in groups according to their main interests or fields of knowledge. For the case study of the IQ, they were divided into groups "A", "B", "C" and "D", where group the people with the most interest or information regarding Habitation were placed in group "A", Culture on group "B", Environment on group "C" and Production on group "D". Group A was the first to position itself regarding Habitation, so that when it was time for other participants to use this Context, they were able first read the opinions of the people who had the most to say about the subject. The same principle applies to group B, which was the first to state their opinions on Culture, whereas groups C and D started the discussions on Environment and Production, respectively. Comments were written and presented in a cyclical fashion, and voting took place as groups provided feedback on each other's contributions (Fig. 12).

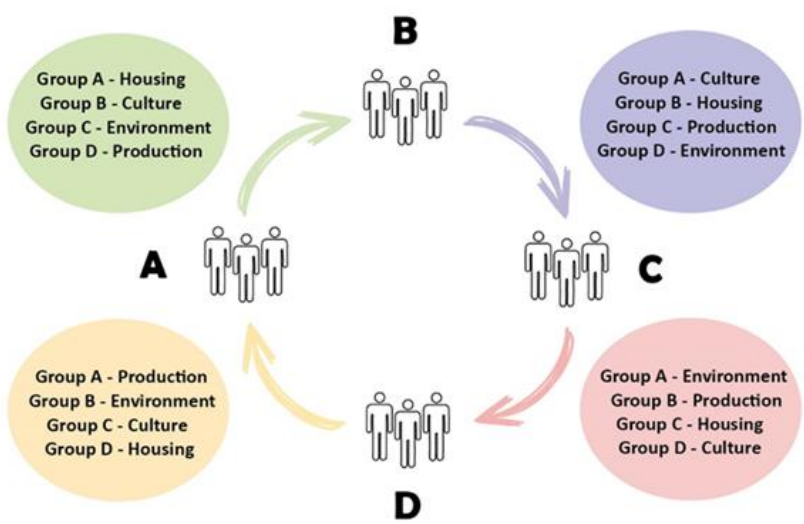



**Figure 12.** Comment cycle and voting

**Source:** The authors.

The idea behind using cycles is rooted on the Delphi method, when it seeks to maximize consensus (Dalkey, 1963). The first to comment and vote on a given Context are those with the most knowledge, affinity, or interest in such topic. When it comes the time for participants from other groups to comment or vote in a proposal, they are in some way influenced by the notes inserted into the Dialog area. Therefore, if a participant still lacks clarity and sufficient information to position themselves in that regard, they will not be influenced by what is already registered, but if they do have some questions, they will surely consider criticisms, warnings, technical information and opinions in order to position themselves on the subject.

## STATISTICS – FINAL NEGOTIATION AND DECISION

When the voting is concluded, the coordinator runs an ETL-based script (Extract Transform and Load) that separates the ideas with less than 40% approval, which are considered rejected; those with 40% to 60% approval, which will need to undergo further discussion; and the ones with more than 60% approval, which are deemed successfully selected. These thresholds can be defined by the coordinator using the ETL interface (Fig. 13).

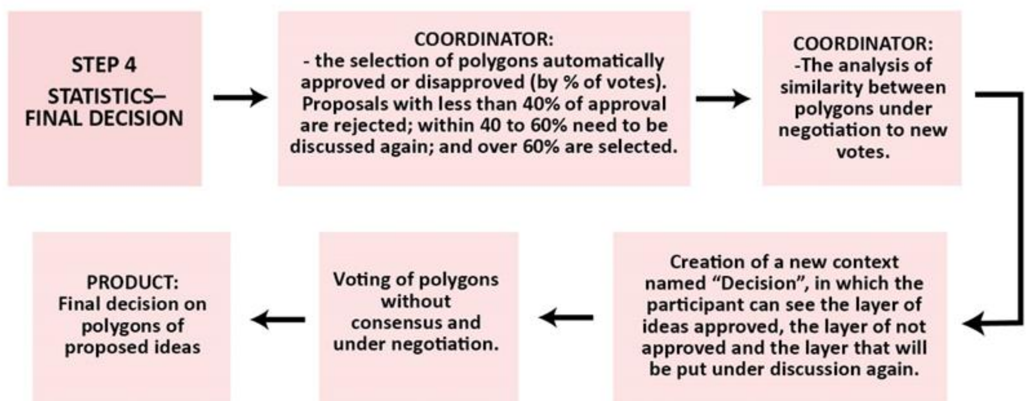



**Figure 13.** Step 4 – Statistics – Final negotiation and decision

**Source:** The authors.

Within the platform, a new Context is then presented and labeled "Decision". In it, the participant can see the layers of approved ideas, as well as the layers with non-approved ideas and the ones that will be subject to further discussion, highlighted according to each theme (Housing, Environment, Production and Culture) (Fig. 14).

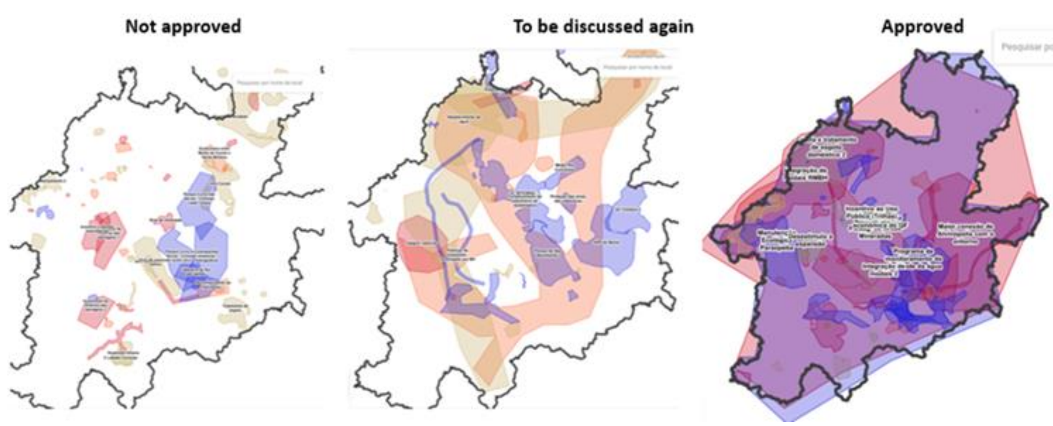
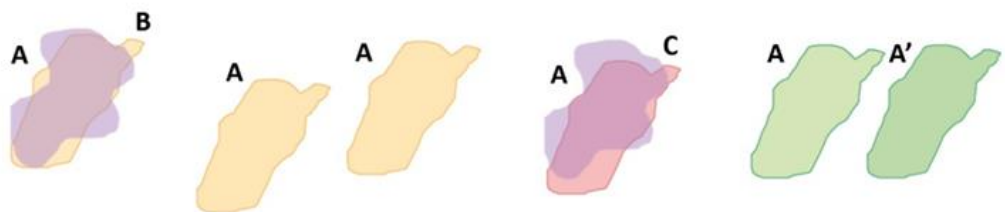



**Figure 14.** The classification of ideas

**Source:** The authors.

There are two important tools that support decision in this new round of discussion: the possibility of interoperability and the ETL of topological similarity. The interoperability resource allows the user to analyze an idea-layer as a database, with associated graphics and tables, and to download polygons with their alphanumeric attributes in any kind of file extension for use on other software applications, such as: CSV tables, Google Earth, shape files for ArcGIS or QGIS, Geojson, and any other GIS platform. Any user can obtain the data required to analyze proposals in any condition and platform they wish, thus amplifying research potential.

The second tool, the ETL script (Extract Transform and Load) serves the purpose of analyzing Topological Similarity, which is the comparison of all polygons to verify if they are "within", "intercepted by" or "containing of" other polygons of the same or other Contexts, allowing to see if there are any possible conflicts or confluences of interest. The script can be executed by the coordinator at any given time but is particularly useful in the stage where participants make decisions regarding the discussed polygons. (Fig. 15).




**Topologic similarity - different geometry and similar ideas in the same place**
**Geography - positional similarity, same ideas to different places in geographical proximity**
**Conceptual - different ideologies and values for the same place**
**Taxonomy - based on semiotics' studies, different words for the same ideas.**

**Figure 15.** Diagrams' Similarity: Topologic Similarity

**Source:** Adapted from Freitas & Moura, 2018.

## DISCUSSION AND CONCLUSION

Coming from the experience of using this new platform and from conducting interviews with participants, we understand that we were correct in substituting or reducing the importance of Evaluation models, in virtue of the wider access to information provided by the SDI system. In order to integrate the platform, the data was previously processed using a model of spatial distribution of occurrences and phenomena, but we avoided reductionism and allowed participants to make decisions by themselves, by selecting information that was already organized in Contexts or even by obtaining extra information from other sources via WMS (web map service).

The stage of Enriching the Reading Experience was also important to make people gain a better understanding of the location and contribute with data that was not available, presenting vulnerability warnings and potentialities. This initial brainstorm prepared users for a more enlightened participation. This time, we did not use step 2, Idea Creation, which is the drawing of polygons in the "Dialog" interface since we already had a numerous list of ideas to be taken into consideration. However, all participants tested the available tools and verified that it was easy and intuitive to draw their own contributions. Not only that, but with less risk of misunderstanding the scale, since instead of a single evaluation map as the background to draw their ideas, they had access to a collection o maps and can make their decisions based in one or more layers that are visualized at once.

The stage of writing comments and voting was effectively used during the workshop, yielding a surprisingly relevant number of comments for each polygon and a significant disposition, from the participants, to express their opinions. It was expected that participants would choose to manifest themselves only on some proposals, the ones that had the most to do with their individual knowledge and interests, but they actually spent a lot of time in this debate and in making contributions over a virtual workspace platform. Since they had enough material to support their opinions as they voted (due not only to the list of comments with other participants' opinions, but also the identification of topological similarities and the visualization of polygons as juxtapositions to a significant amount of thematic maps), they were quite confident in their judgments.

When the voting was done and a final decision was achieved, on steps 3 and 4, it was possible to see that the geographical positions, the names and descriptions of the polygons, when applicable - built in the other platform according to the other structure -, were not enough for people to grasp the ideas, and therefore many of them ended up not being selected. This occurs because, during the other process, the drawing and the graphical representations are more important than the alphanumerical data that are attached to the polygon, which no longer happens in this new work approach, since the participant is encouraged to describe their own proposals and comment or discuss others'. This process was based on Delphi, in which the observation of others' opinions can lead a participant to change their position in case they are not sure of what they are talking about.

In comparison to previous experiences, it is possible to say that the structure and the adapted platform carry resources that improve the experience of co-planning a complex territory such as the QF and its spatial inequalities. The black box that previously defines the "where", "when" and "what" was hence avoided. The possibility of receiving all the data in the format of and SDI (Spatial Data Infrastructure) and to increment the collection with opinions or with data from other platforms, and not only a synthesis that could conduct the decision telling where to do what, made the participants secure to present their ideas, what is also a condition to face inequalities in access and use of digital spatial information.

The structure and the platform are an open field of work that is in perpetual construction, since each case study bears its own set of peculiarities. New tools are being developed to improve geovisualization and interoperability, not only between machine and software, but mainly the interoperability of invested parts.

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## *References*

ABUKHATER, A.; WALKER, D. Making Smart Growth Smarter with Geodesign. In.: **ESRI, Changing Geography by design**. Redlands, CA, 2010.

ANDRIENKO, G.; ANDRIENKO, N.; KEIM, D.; MacEACHREN, A.; WROBEL, S. Challenging problems of geospatial visual analytics. **Journal of Visual Languages and Computing**. 22(4), p.251-256, 2011.

BALLAL, H. Collaborative planning with digital design synthesis. **Doctoral Dissertation**. University College London, 2015.

BALRAM, S.; DRAGICEVIC, S. **Collaborative geographic information systems: Origins, boundaries, and structure.** Idea Group Publishing, 2006.

BATTY, M. Planning Support Systems: Progress, Predictions, and Speculations on the Shape of Things to Come. UCL, **Working Papers Series**, 122, p. 1-25, 2007.

BRASIL, **Decreto Nº 6.666, de 27 de novembro de 2008**. Institui, no âmbito do Poder Executivo federal, a InfraEstrutura Nacional de Dados Espaciais - INDE, e dá outras providências.

BURGERS, G.; KLEIJN, M., MANEN N. Urban Landscape archaeology, geodesign and the city of Rome. In: Lee D., Dias E., Scholten H. (eds) Geodesign by Integrating Design and Geospatial Sciences. **GeoJournal Library**, 111, 2014. doi: 10.1007/978-3-319-08299-8_12

CASAGRANDE, P.; MOURA, A.C.M. The Geological Workshop of Geodesign for Landscape Planning. In Leone, A. & Gargiulo, C. (Eds.), **Environmental and territorial modelling for planning and design**, p. 595-602, 2018. Naples: FedOAPress. doi: 10.6093/978-88-6887-048-5

CHEN, Y.; DANG, A.; PENG, X. Building a Cultural Heritage Corridor Based on Geodesign Theory and Methodology. **Journal of Urban Management**, 3(1–2), p. 97-112, 2014. Doi: 10.1016/S2226-5856(18)30086-4.

CRAGLIA M. and CAMPAGNA M. **Advanced Regional Spatial Data Infrastructures in Europe**. European Commission; Joint Research Centre; Institute for Environment and Sustainability, 2009.

CRUMLEY, C.; KOLEN, J.; KLEIJN, M. & MANEN, N. Studying long-term changes in cultural landscapes: outlines of a research framework and protocol. **Landscape Research**, 42 (8), 880-890, 2017. doi: 10.1080/01426397.2017.1386292

DALKEY, N.; HELMER, O. An experimental application of the Delphi method to the use of experts. **Management Science**, 9(3), p.351-515, 1963.

EIKELBOOM, T., JANSSEN, R. Collaborative use of geodesign tools to support decision-making on adaptation to climate change. **Mitigation and Adaptation Strategies for Global Change**, V.22, p.247–266, 2017. doi: 10.1007/s11027-015-9633-4

ELMES, G.; DOUGHERTY, M.; CHALLIG, H.; KARIGOMBA, W.; MCCUSKER, B.; WEINER, D.; FISHER, P. Local knowledge doesn't grow on trees: Community-integrated geographic information systems and rural community self-definition. In.: FISHER, P. F. (Ed.), **Advances in spatial data handling**. Berlin: Springer Science and Business Media, p. 29-40, 2004.

ELWOOD, S.A. Beyond cooptation or resistance: Urban spatial politics, community organizations, and GIS-based spatial narratives. **Annals of the Association of American Geographers**, 96 (2): p. 323–341, 2006.

FLAXMAN, M. Fundamentals of Geodesign. In: Buhmann, E., Pietsch, M. & Kretzler, E. (Eds.), **Peer Reviewed Proceedings of Digital Landscape Architecture** 2010. Berlin/Offenbach, Wichmann, p. 28-41, 2010.

FREITAS, C., MOURA, A.C.M. ETL Tools to Analyze Diagrams' Performance: Favoring Negotiations in Geodesign Workshops. **DisegnareCon**, 11(20), p. 1-23, 2018.

GEERTMAN, S, STILLWELL, J. (Eds.), **Planning Support Systems Best Practice and New Methods. Springer Netherlands**, 2009. 490 p. DOI: 10.1007/978-1-4020-8952-7

HAYEK, U.; WIRTH, T.; NEUENSCHWANDER, N. & GRÊT-REGAMEY, A. Organizing and facilitating Geodesign processes: Integrating tools into collaborative design processes for urban transformation. **Landscape and Urban Planning**, 156, p. 59-70, 2016. doi: 10.1016/j.landurbplan.2016.05.015

KINGSTON, R. Public Participation in Local Policy Decision-making: The Role of Web-based Mapping. **The Cartographic Journal**, 44(2), p. 138–144, 2007.

KOLEN J., MANEN N.; KLEIJN M. History Matters: The Temporal and Social Dimension of Geodesign. In: LEE D., DIAS E., SCHOLTEN H. (Eds) Geodesign by Integrating Design and Geospatial Sciences. **GeoJournal Library**, 111, 2014. doi: 10.1007/978-3-319-08299-8_11

MacEACHREN, A.; GAHEGAN, M.; PIKE, W.; BREWER, I.; LENGERICH, E., HARDISTRY, F. Geovisualization for knowledge construction and decision-support. **Computer Graphics & Applications**. 24(1), p. 13-17, 2004.

MOURA, A.C.M. Geodesign in Parametric Modeling of urban landscape. **Cartography and Geographic Information Science**, 42(4), p. 323-332, 2015.

NYERGES, T. L.; JANKOWSKI, P. Enhanced adaptive structuration theory: A theory of GIS-supported collaborative decision making. **Geographical Systems**, 4(3), p. 225-257, 1997.

PEUQUET, D., MARBLE, D. **Introductory readings in Geographic Information Systems**. London, Taylor & Francis, 1990.

RAPINE, A., MELLO-SILVA, R.; KAWASAKI, M.C. Richness and endemism in Asclepiadoideae (Apocynaceae) from the Espinhaço Range of Minas Gerais, Brazil – a conservationist view. **Biodiversity and Conservation**, 11, p. 1733-1746, 2002.

RIVERO, R.; SMITH, A.; BALLAL, H., STEINITZ, C. Promoting Collaborative Geodesign in a Multidisciplinary and Multiscale Environment: Coastal Georgia 2050, USA. In.: Buhmann, E., Ervin, S. M. & Pietsch, M. (Eds.). **Peer Reviewed Proceedings of Digital Landscape Architecture**, p. 42-58, 2015.

RUCHKYS, U., MACHADO, M. Patrimônio geológico e mineiro do Quadrilátero Ferrífero, Minas Gerais – caracterização e iniciativas de uso para educação e geoturismo. **Boletim Paranaense de Geociências**, 70, p. 120-136, 2013.

SIEBER, R. Public participation geographic information systems: A literature review and framework. **Annals of the Association of American Geographers**, v. 96, n.3, p. 491-507, 2006.

SONTERA, L.; BARRETT, D; SOARES-FILHO, B.; MORAND, C. Global demand for steel drives extensive land-use change in Brazil's Iron Quadrangle. **Global Environmental Change**, 26, 2014, 63-72, 2014. doi: 10.1016/j.gloenvcha.2014.03.014

STEINITZ, C. **A Framework for Geodesign: Changing Geography by Design**. ESRI Press, Redlands, 2012.

WU, C.; CHIANG, Y. A geodesign framework procedure for developing flood resilient city. **Habitat International**, 75, p. 78-89, 2018. doi: 10.1016/j.habitatint.2018.04.009.

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