COMPLEMENTARY WEB-BASED GEOINFORMATION TECHNOLOGY TO GEODESIGN PRACTICES

STRATEGIC DECISION-MAKING STAGES OF CO-CREATION IN TERRITORIAL PLANNING

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ABSTRACT

The teaching of territorial planning requires students be trained in geo-information technology tools. The practice was held on engineering course in the University of Bologna and intended to train students in the use of geodesign methods to co-create alternative futures proposals for a territory by applying the framework proposed by Steinitz and using the GeodesignHub web-based platform. The method assumes the construction of representative and evaluative models about the place before the workshop stage, when users are put in contact with data already produced. In order to avoid misunderstanding, noises and encouraging active participation during the workshop, sharing-decision mechanisms using web-based geo-information technology tools were tried, adjusted for the expressive capacity of young millennia in the use of digital social media. As methods, we explored the possibilities of Crowdsourcing Mapping to gather information about main characteristics of the area, WebGis to share georeferenced maps and favor combinations of variables, Delphi method to maximize consensus, Geo-questionnaires for territory evaluation, Word Cloud and Hashtags for ontologies association of design ideas. The case study was Faenza, in Emilia-Romagna, since we had access to VAS data and assessments for the region. As a result, the interest and quality of participation in the co-creation workshop for the area was significantly increased and it was possible to observe the easiness of understanding the processes, due to the improvements applied in language visualization, so that the experience favored the development of knowledge and skills.

KEYWORDS

Territorial Planning, Geodesign, Web-based Tools; Visualization, Co-creation

1 INTRODUCTION

The development and popularization of geo-information technologies have significantly transformed the methodological processes in urban planning. Since the creation of GIS - Geographic Information Systems, the expansion of resources has been observed in the production of data, in the transformation of data into information, and in the possibilities of transforming information into knowledge. In the last decade, a new phase in these technologies is highlighted, with the inclusion of the possibilities of the world-wide computer network as a working platform, which results in the beginning of the popularization of the production and use of georeferenced information, bringing a new era in methodologies of spatial analysis and planning.

Geographic Information Systems were born in the 1960s in Canada, based on desktops and intended only to those who had specific knowledge in the subject, because it was necessary to comply with the first technical steps of development. A GIS, according to Burrough (1986) should fulfill the functions of favoring the acquisition, storage, retrieval, transformation and emission of spatial information. The systems are based, according to Aronoff (1989) on the use of spatially referenced data, and are structured in actions of input, management, manipulation, analysis and output of georreferenced data.

The first challenges, in this sense, were to overcome the steps of organization, disclosure and access to databases on local computers or internal networks. Peuquet and Marble (1990) classified the initial stages as "process-oriented approach", "application approach", "toolbox approach" and "database approach". Then, according to Moura (2015), the challenge was to invest in "visualization approach", based on investments in visualization that favor that the users participate in the stages of spatial analysis in a more conscious way and understanding better their choices.

We are facing new paradigms in the use of data, due to changes in the platforms for geo-information technologies. The group of users is expanding, and nowadays those who work with GIS science are not restricted to technicians who have expert knowledge, but all the citizens that need to have access to georeferenced information. The platforms leave the sphere of the desktops and install themselves in the world-wide network of computers, on the web. In this sense, the two changes complement and make possible: web access and citizen interest, one enhancing the other.

In spatial and urban planning, spatial analyzes have become more robust based on the use of geoprocessing resources and, more specifically, the application of models made possible by the use of Geographic Information Systems. Spatial analysis models favor the representation, visualization, evaluation and simulation of combinations of variables, constructing diagnostic and prognostic analysis. According to Moura (2012, 2014) the intention is a broad support for decision-making. But these decisions need to be shared, as this is a contemporary value in territorial planning.

It is believed, therefore, that the full employment of GIS potential should advance in the production of information from the existing data, favored by the use of a logical structure to build information to support decision-making. The interest in methodological processes in decision making on alternative futures of a territory supported by geoinformation technologies has been in the focus of the attention of planners since 2012, when the logic of Geodesign, design, design "with" and " for "the landscape. Geo - land / territory + Design - design, project (Batty, 2013; Steinitz, 2012).

For Miller (2012) the logic of Geodesign arises in the studies of landscape planning, following a thought already presented by McHarg (1969) in "Design with nature", through which the territory is interpreted according to its components or main variables and the arrangement between them. The variables are organized into information plans and their combinations are performed to identify the areas of constraints

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and potentialities to the uses, vulnerabilities and attractiveness. Steinitz (2012), who teaches landscape planning since the 1960s, has developed methods for integrating actors, actions, variables, and decision-making processes into territorial planning at different scales.

For the application of the logic of Geodesign, Steinitz (2012) proposed a framework, a logical structure applying geo-technology resources. The methodological framework is structured in work stages, with the purpose of supporting the characterization, analysis, evaluation of potentials and constraints, simulation and prediction of future possibilities for an area. However, the most important phase is the stage of elaboration of proposals of projects and policies for the territory, carried out in actions of decision making. Throughout the methodological process there is a strong inclusion of the visualization component to support decision making. The logic is the co-creation, in co-design of alternative futures for the territory. The urban plans are not only technical, but are also decoding of collective values, avoiding the top-down plans, and proposing methods to listen to expectations from different actors. But the technical opinion continues to have value, so it is necessary to put together the technical, the administrative and the people of the place. The digital platforms that support the process need to be well structured and favor the broad understanding by all groups of participants. They also need to make the role of the actors involved clear, the tasks to be accomplished, the moments of review and evaluation, the moments of decision making.

Steinitz's proposal for Geodesign presents a framework to allow this collective participation in steps. Thus, the author proposes a framework with six action stages that happens throughout the models of representation, processes, evaluation, simulation, proposition and decision. A landscape intervention project, such as urban landscape planning and management, follows the steps of answering these questions: How can the area be represented? How does it work? Is it working fine? How can it be changed? What impacts can the changes cause? What should be proposed for the area? (Fig. 1).

Steinitz's proposal can be developed even on an analog platform, by overlaying maps and designing landscape change proposals, but the dynamics and co-creation of designs are much more optimized if users work on a digital platform in which they have simultaneous access to the information and dynamically visualize results of the proposals. To support this dynamic, web-based platforms are the most appropriate. In recent years, the author has worked mainly on the GeodesignHub platform, developed by Hrishikesh Ballal (Ballal, 2015). In this platform the participants have contact with the main systems that characterize the potentialities and limitations of the study area, elaborate proposals of projects and policies for each thematic contained in the systems, and gather these proposals in the form of designs, which have the Master Plan character of ideas for territorial transformation. From experiences in different scales of approach, we observed some challenges to be faced, so that the users had their optimized participation, felt comfortable and confident in the different stages, and this security should come from the amplification of the conditions of understanding the information. The criticisms observed in previous experiences, for which studies of the application of additional mechanisms have been developed. They were:

- understanding the composition of the systems, and the content portrayed in the systems. Investments in the graphical treatment of information and the presentation of information (Zyngier et al., 2016);
- possibility of using data of different origins and use of data produced in the Geodesign process in other platforms, so that users could choose languages and platforms where they feel more comfor. This means investments in interoperability between systems (Moura et al., 2016);
- adaptation of languages according to the values of different groups of users, investing in mechanisms of local reality visualization, such as the three-dimensional modeling resulting from data capturing that

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favors the relationship between system maps, mental maps and observed reality (Monteiro et al., 2018; Zyngier et al., 2017);

- the importance of allowing users to understand the main components/variables that characterize the study area, and prepare them to give their opinions in the proposal elaboration workshop (Casagrande & Moura, 2018).

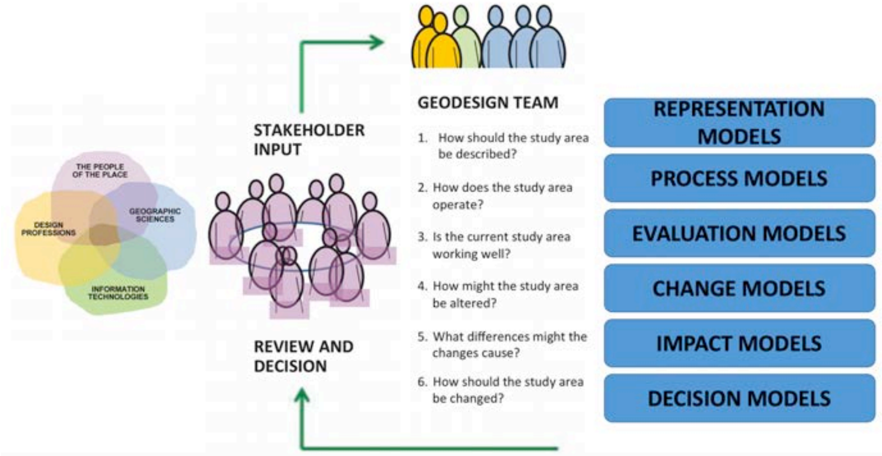

Fig. 1 Steinitz's framework for Geodesign (adapted from Steinitz, 2012)

From these experiments of expansion and adjustments of the possibilities of the Geodesign, the case study of Geodesign Faenza was developed, whose workshop was held at the University of Bologna, in an academic context, in 2017. The objective was to train engineering students in territorial planning with the use of geo-information technologies. The spatial cut was the municipality of Faenza, because one of the teachers involved worked in the VAS (*Valutazione Ambientale Strategica* – Strategic Environmental Assessment) of the region and presented extensive knowledge and data about the territory, and the municipality is located in the area of influence of the University of Bologna, Emilia-Romagna.

The methodological approach was to increase the use of the web platform in several work stages, due to the recognition of the new stage in the use of geoinformation technologies that are migrating from the desktop platform to the global computer network. The conceptual cut was the adoption of languages that could be more easily captured by the generation of young students, the so-called "Millennials" (generation Y), so that they could participate in activities intuitively and learn from experience. The time cut was the insertion of the workshop and the explanations about Geodesign in territorial planning during 4 meetings of an undergraduate course, one of which was devoted to the preparation of data and recognition of the area, two for the workshop and one for the conceptual basis.

The main challenge, which was the main methodological contribution of the case study, was the work in the language of the generation Y students and the use of different web-based applications to support each step of Geodesign. According to Prensky (2001) the generation Y is one that was born at the turn of the 21st century and reaches maturity at the beginning of the century. It is a generation that is born inserted in digital tools, being called digital natives. For them everything is online and technology is something natural.

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They are all native speakers of the digital language of computers and the Internet. Thus, they have a special role in society, which is to translate this new language to previous generations, favoring them to be included in the new collective platforms, since this is the media where decisions are already being made, which tends to expand. In that sense, teaching Geodesign to Millennials requires new processes, but testing with these youngsters would also give us answers to new visualizations to be used in other future workshops.
In this sense, the case study had the following objectives:

- to develop an academic workshop to train students of generation Y in the use of geo-information technologies for territorial planning, in collaboration between the EA-UFMG Geoprocessing Laboratory and the University of Bologna, a civil engineering course;
- To observe the performance of the members of the generation Y in the use of a set of web-based applications that would favor the virtual knowledge about the territory of analysis, the manifestation of opinions on the case study and the learning of the collective construction of a Master Plan for the area;
- propose and test web-based applications for the various stages of Geodesign, with emphasis on those where it was important to take and receive information and opinions from users.

2 METHODOLOGY

The methodology was based on the following work stages:
Representation Model - Aims to explain how the area can be described. In order to make the decision about the alternative futures considering the main variables, selecting the components that best explain the characteristics of the area, it is important to listen to the local people, and also to listen to the workshop participants. To implement this "listening" mechanism, a crowdsourcing-mapping application was developed in which people could register their points of view, georeferencing elements to be observed in the case study. Process Model – Aims to explain how the area of the case study works. Based on the opinions expressed by the actors, describing the main characteristics to be observed in the territory under analysis, the organizers could translate these impressions into technical maps that make up distribution surfaces of phenomena and occurrences. They construct thematic maps that show the reader what is happening in the territory, where and how. These thematic maps were made available to students via web platform in a WebGis application.
Evaluation Model - Aims to tell if the area of the case study is working well. Due to the access to the expressive set of information about the main characteristics of the area, users are asked to answer a web-questionnaire describing what they understood about the main components that were in WebGis. In this online questionnaire they describe each thematic system, conducting evaluations and judgments. Based on the analysis of what they described, the technical group performs the composition of the evaluation maps, which are judgments about where, in the territory, the main issues have already been resolved, where there is still a need and potentiality for interventions, and where it is inappropriate to propose changes.
Change Model – Aims to tell where and if the area can be changed. During the workshop stage, when the participants get together in front of computers, they are organized in groups of society representatives, and begin their collaborations by proposing projects and policies for the area of the case study, separated by themes (which are called "systems" of interest). It turns out that because users do not act as planners in their daily life, they often find it difficult to translate their expectations into ideas that are presented in georeferenced diagrams or polygons. The organization of ideas and the presentation of suggestions are not trivial, as those people are not planning professionals who are accustomed to translate challenges and

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difficulties into design proposals. Thus, to have the participants more prepared to present their ideas in the composition stage, which is the model of change, they were asked to answer a web-questionnaire, to register their initial suggestions to solve the needs of each system, summarized in keywords. These keywords, which are proposed to be developed for the area, were organized in a list and shared with everybody in the first stage of the workshop, helping to "break the ice" in creating project and policy diagrams.

Impact model - Aims to judge the impacts that the proposed changes can cause in the territory. In the platform used in the Geodesign workshop, GeodesignHub (Ballal, 2015), there is a data entry in the form of a combination matrix of rows and columns, which informs the level of impact of proposals from one system to another. For example, what is the impact of constructing a park in an area of industrial interest?. There are combinations that generate negative impacts, other with positive impacts, and there are still the neutral impacts. This cross analysis impacts need to be informed in the system before the workshop, so that, by dynamic cartography, while the diagrams of proposals are designed, the users can control the impacts they can produce. But deciding if a proposal can cause an impact is not trivial, and it is interesting to share this decision. In this sense, for the case study a web tool was used to apply the Delphi method, capturing the opinions of the participants in an initial round, averaging the opinions, informing the result of the averages to the participants, carrying out a second round of review of opinions, from which the final decision is reached.

Decision Model - Aims to tell what should be proposed for the study area. During the Geodesign face-to-face workshop, which takes place with the use of the GeodesignHub web-based platform, participants design projects and policies of the area, separated by systems that are the themes of interest. Then, organized into groups that represent society's interests, they choose ideas (which are the diagrams of policies and projects) among all the diagrams construct by everybody, selecting those which, in their opinion, are the most appropriate. This set of ideas composes "designs" that resemble the proposed "Master Plans". It is part of the dynamic of the Geodesign workshop to make several designs, by each team of representatives, and to create new proposals collectively, until the work reaches, by approximation and negotiation, a single final proposal. This proposal, even if it was created collectively, is the proposal of a group of society representatives, and it is necessary to verify how much the other people of the area, who were not in the workshop, would accept the plan. In order to favor this extension of discussion and decision, a web-based consultation called "voting" was applied, which captures the opinions about the diagrams per system.

3 THE WORKING STEPS DEVELOPMENT

About the working steps, the elaboration of WebGis stands out among the applications chosen to give support to each model. It made the understanding about the main characteristics of the area possible to the users, the composition of the analyses by theme and the integration of variables to create the evaluation maps. The other steps also had their importance because they acted as “listening” about values and expectations, but WebGis stands out as a way to make the participants understand how the organizers worked from the input of the base maps and combined them to construct thematic evaluation maps that were very important as reference to the design of projects and policies during the workshop meeting.

The application has the potential to bring technical information to citizens’ understanding, from the listening of expectations to the decoding of values registered by the participants. Explanations about the challenges of composing evaluation maps are a key step in Geodesign, and will be presented separately in the next topic.

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3.1 CROWDSOURCING-MAPPING

The logic of crowdsourcing is about delegating tasks to a group of people or encouraging a group of people who do not necessarily have a previous connection with the action. The principle is explained by Goodchild (2007a), who characterizes the process as "citizens as sensors" in which people collaborate with the recording of information, a process that according to Davis Jr et al. (2013) can be voluntary (when registering on a map, for example, by collaborative mapping) or passively (when their data is recorded and processed by applications, without explicitly asking the users to collaborate). The voluntary process is also known as VGI (Volunteered Geographic Information). In the specific case of crowdsourcing-mapping the goal is to make people collaborate with information, opinions and highlighting the main characteristics of an area, registering elements on a georeferenced map available on a web-based platform. Among the most popular applications that favor these collaborations are Ushahidi (that produced Crowdmap), Maptionnaire, Map Me, Story Map and ArcGis Online, among others. The collective mapping, according to Pánek and Pászto (2017), has been associated with Emotional Mapping by Nold (2009), since people record their opinions and preferences, or by Sentimental Mapping according to Caragea et al. (2014), or even Ephemeral Mapping, according to Art and Cartography Commission from ICA (2015) because they report records that are not permanent but are opinions and judgments that may change over time. This mapping is associated with feelings because in addition to recording where and what, that information can be evaluated by other users, who make comments and approve or disapprove of the element. In the case study we chose to use Crowdmap, because it is a free platform and, in the judgment of the organizers, well known. However, there was a low adherence of users regarding the interest in posting their suggestions and opinions. Some have expressed difficulties in using the application, which does not provide clearly understandable navigation. (Fig. 2). The phenomenon of low adherence to the process is already known. There is a set of scientific publications that report difficulties in having adhesion of collaborators in using crowdsourcing-mapping in general, and the experiments that work, are those encouraged by a specific project. Goodchild (2007b) explains that people only participate, motivated by self-promotion in social media, or when they may have some gain in knowledge or to reach a personal interest. Some researchers have created mechanisms for encouraging and co-opting collaborations, such as Mission-Oriented, which is a process of taking the request of participation to specific groups, according to profile or geographic location (Mateveli et al., 2015). Although collaboration has been very low, which has resulted in non-support for the characterization of the area, we still believe that in future studies it is possible to propose the same logic of using a web-based platform for citizen listening formatted in a way that favors the interface. As a consequence, it was not possible to use the results captured to define the main component variables, according to the potentialities and vulnerabilities of the area, therefore the technical group chose to study the documentation of the Municipal Structural Plan of Faenza about the territory, and from it to identify the main information that should compose the Representation Model of the case study.

3.2 WEBGIS

The use of a WebGis as a complementary application was used a lot by the participants before and after the workshop, and was a very important innovation in Geodesign, proposed in this case study and extended in others that succeeded it.

From the technological point of view, WebGIS can undoubtedly play an important role as a facilitator of communication. It stands out when it has the possibilities for three-dimensional visualization with the

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support of appropriate technologies, dissemination of information for collaboration and participation, promoting a communication not only "unidirectional", but mainly "bidirectional". This tool can certainly also be effective in different phases of the Geodesign process, especially in the steps of analyzing information and judging existing conditions. WebGIS adds the ability to share information in a distributed environment, which is useful when, as in the case study, there are different groups working on the same information base and needing to interact.

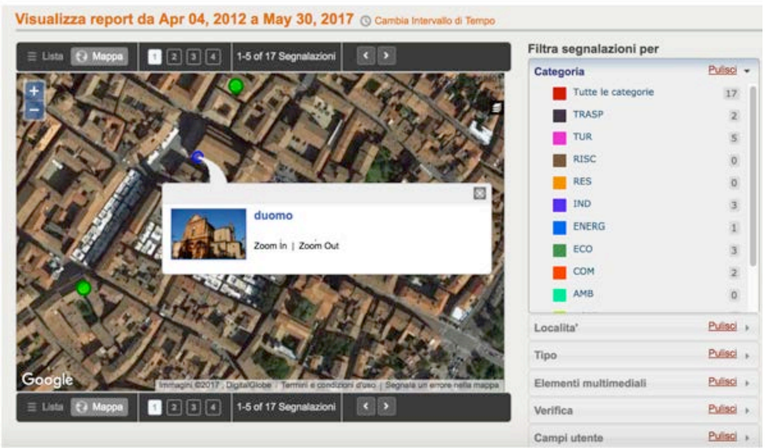

Fig. 2 Crowdsourcing to collect values and information about Faenza

In the case study of Geodesign methodology to develop proposals for the territory of the Municipality of Faenza, the data that composed a cognitive picture about the area were collected from the Municipal Structural Plan of Faenza and organized into ten main themes, from which the participants began a debate on the interpretation of existing conditions on particular aspects: environment, trade, industry, transport, public administration, and so one. (Fig. 3).

The cognitive data structure was created with the GIS and WebGIS tools, identifying ten thematic axes of information that delineate the territory conditions and presents its most relevant characteristics:

- AGRI – AGRITOUR (Agriculture and Tourism) – To plan possibilities in agritourism;
- AMB (Environmental) – Environmental interests, to protect vegetation, water resources, etc.;
- ECO (Ecology) – To face the risk of pollution in air, water, noise and the production of garbage;
- RISKS (Geotechnical Risks) – To face risks in landslides, inundation, seismic, etc.;
- TRASP (Transport) – To plan possibilities in transport like roads, cycling tracks, etc.;
- RESI (Housing) – To plan housing areas;
- COM (Commerce) – To plan commercial and services areas;
- TOUR (Tourism) – To plan cultural tourism;
- ENER (Energy) – To plan possibilities in renewable energy, like biomass, solar energy, etc.;
- IND (Industry) – To plan industrial areas and activities.

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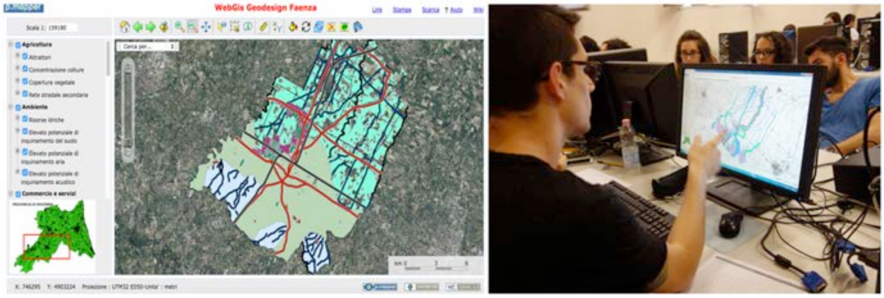

Fig. 3 WebGis to present the main characteristics of the area, organized by the main themes

The technology of WebGIS implementation chosen was that of the "server-side" type. In this case, processing takes place mainly through the server and it results in some advantages but also in disadvantages. Among the advantages, for the purposes of the case study, the facilities in programming the user interface due to the availability of packages already developed in "free code" can be mentioned, which means a reduction in implementation time. Among the disadvantages, there is the lesser capacity for interactivity of the "server-side" configuration (such as the greater difficulty to be used on mobile devices) which, however, did not create particular critical issues in the development of the Geodesign process, as most people used desktop computers.

The WebGIS created for the case study, from the point of view of information content, uses the same database developed in the GIS. The WebGIS, however, was implemented for the purpose of having the information accessible and available to the user through the web. The query interface is relatively easy to use, compared to GIS interface, although with less conditions to data management and spatial analysis, since the application allows relatively simple access, intended for users not necessarily "specialists" in technologies of geoinformation. In addition, the WebGIS environment offers more possibilities for interaction, both for possible modifications of the cartographic data and for the creation of a "cooperative" environment through the sharing of information through networks that, however, were only minimally explored in the present case study.

WebGIS has been implemented with open source software, using the following components:

- apache Web server with CGI interface (Common Gateway Interface) and PHP language for the communication between Web Server and resident software;
- mapserver as map server;
- data management environment (DBMS) Postgresql-Postgis (shared with the GIS);
- p.mapper user interface (in PHP-Javascript language). (Fig. 4).

3.3 WEB-QUESTIONNAIRE TO PERFORM LISTENING ABOUT THE VALUES

From the visualization of an expressive collection of thematic maps organized by system, in which were presented both the basic maps on the location of the main elements and also those that inform the distribution and concentration of phenomena related to the theme, users were asked to access a web-questionnaire from Google Forms. (Fig. 5).

In this questionnaire, answered online, they should write a paragraph describing what they understood about each system: what were the main characteristics, potentialities, vulnerabilities. From this brief

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description it is possible to capture the collection of understandings, and from there arise the descriptions of the essences that characterize each system in the case study.

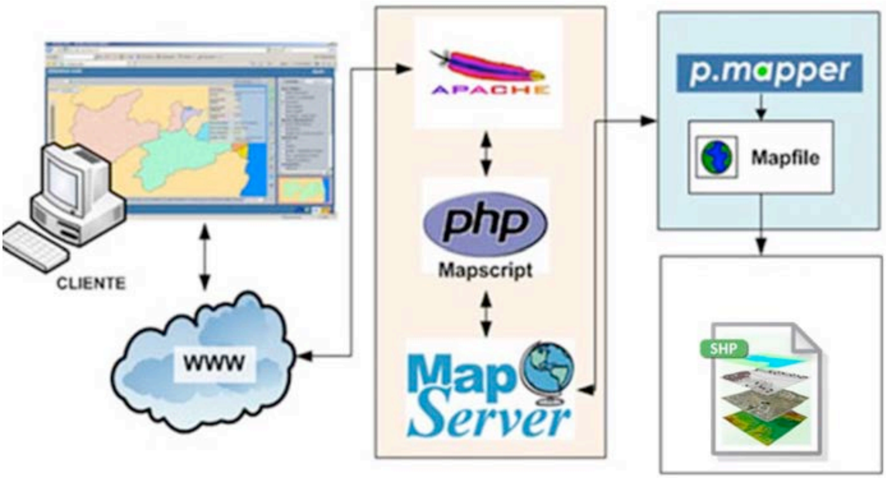

Fig. 4 The structure of the WebGis

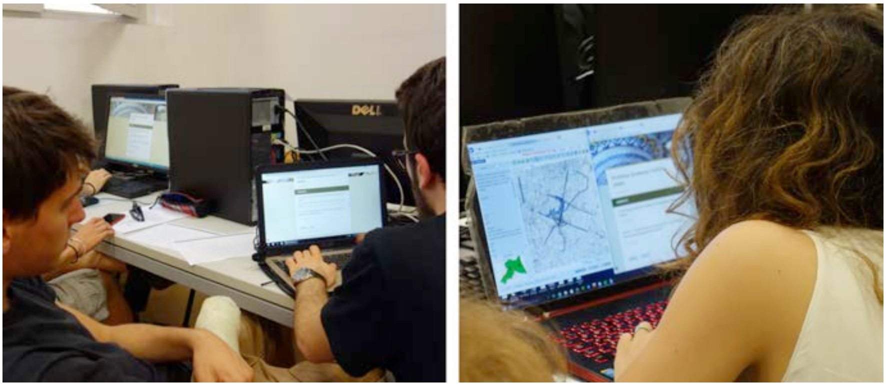

Fig. 5 The Web-questionnaire in order to understand the main values

The organizers then collected all texts, from all users, by system, and made a summation in a text file, which was visualized in a cloud of words. Word-Cloud is a digital graphic that shows the frequency of words in a text. The more the word is used, the more striking the representation is of that word in the graph. (Fig. 6). As a result, it was possible to highlight what people think as main values and demands for each system or theme, and this was a support for the construction of evaluation maps, which are judgments about where it is possible and where it is necessary to make proposals for changes in the landscape.

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3.4 WEB-QUESTIONNAIRE TO COLLECT SUGGESTIONS AND IDEAS

In the same application where the user was asked to interpret the system, a request was also made to suggest ideas to solve the main problems and to meet the main demands and potentialities by theme. Using also Google Forms, the user was asked to write up to five keywords per system, with ideas to be developed for the territory.

The goal was to create a set of initial ideas that could be developed in the form of georeferenced diagrams as soon as the workshop started. The reason for asking them to think about the possibilities is justified by the need to put the participants to think about issues that would be discussed at the meeting and to activate their minds to build ideas. This would reduce the initial difficulty of proposal composition and would already indicate trends and values to be pursued in the workshop.

Fig. 6 The Word-Cloud with the main ideas about the area, by topic

Upon arriving at the face-to-face workshop, users were able to see on the blackboard the entire list of all the ideas already indicated, per system, and as new ideas emerged, they were included in the cast. This list could also be distributed by a document shared on the web and projected onto a screen, but it was quite dynamic to have the relationship visibly placed on the blackboard. (Fig. 7). Adding to the list of ideas to be developed, the GeodesignHub developer, Hrishi Ballal, introduced the functionality of adding hashtags to the diagram drawings, so that it would be possible to search for keywords and identify if another user had already proposed something similar to what was under planning. Notwithstanding that similar new ideas could also be designed, but it was a way of identifying common expectations that could be used as strategies of negotiation and consensus.

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Fig. 7 The Web-questionnaire to get ideas to be developed, in keywords. Blackboard with the keywords per system

3.5 WEB-BASED DELPHI CONSULTATION

The GeodesignHub platform is programmed to receive an indication of values in a system combination matrix, in which it is defined what the possible impacts will be of a project or policy proposed to a specific theme in positions that would also be of interest to other themes. But this decision is not trivial, and it is common for participants to have divergent opinions on these judgments, ranging from the most positive to the most negative, going through the neutral. (Fig. 8).

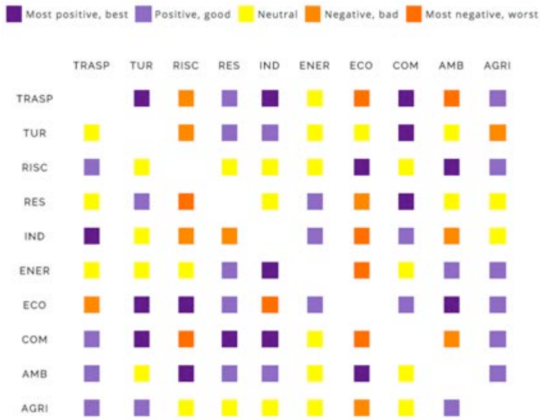

Fig. 8 The systems combination matrix

To have the opinion from the participants about how a proposal planned to one system could disturb the other interests positively or negatively, they were asked to give their opinion on the composition of the final decision on what the impacts of the proposals would be. To collect the opinions, the Delphi method was used to construct consensus.

The Delphi method was first proposed in the 1950s by the US military, the Research and Development (RAND), with the goal of dividing responsibilities and arriving at the best solution that would be a consensus among those participants involved. The name comes from the Delphi Oracle, because the goal is to support decision making. The argument is that group judgments are closer to reality and more accurate than

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individual judgments. According to Dalkey and Helmer (1963) the method is composed of questionnaires applied in rounds to experts or invited participants, and these rounds are interspersed with feedback, aiming at the convergence of participants' opinions. Although some authors, such as Linstone and Turoff (2002) argue that the number of rounds should be as many as necessary until convergence of opinions is reached, we believe that absolute consensus does not exist, and what can be done is searching for maximized consensus, which led us to opt for the use of two rounds.

In the case study, the SurveyMonkey platform was used, which is not free-access, but it could also be possible to use a Google Form to do something similar. The users were asked to judge the combinations between systems as -2 (most negative), -1 (negative), 0 (neutral), +1 (positive), and +2 (more positive). We asked the participants to keep the notes about their first opinion. The average of all opinions was calculated, per combination, and the result was presented so that the participant could compare the opinion of the majority with his own opinion, and he had the right to make adjustments, if he wanted. A new final average was calculated, and GeodesighHub was settled with these values. (Fig. 9).

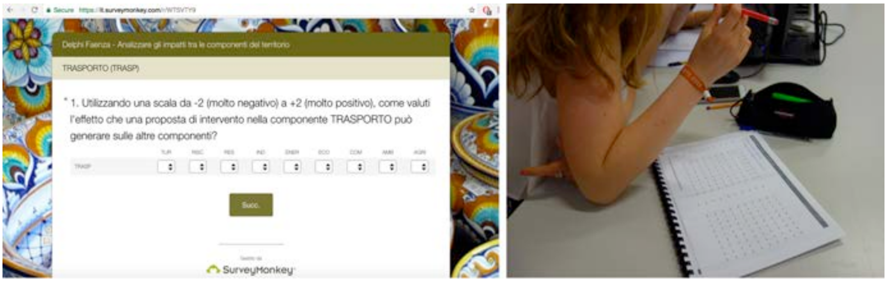

Fig. 9 Delphi web-based. The two rounds of opinions

3.6 THE WEB VOTING SYSTEM FOR THE FINAL DECISION

Since face-to-face meetings in Geodesign workshops can only receive a limited number of participants, chosen as representatives of the society, it is important that the proposals built by this group are evaluated and validated by a larger number of people. In this sense, the programmer of GeodesignHub, Ballal, created a voting mechanism in which, through a link, those interested can access the results of the workshop and evaluate, by system and diagram, if they are in agreement with the idea, indicating "approved" or "not approved". Being aware that web-based opinion queries should be fairly streamlined and brief, the user sees each diagram at a time to vote. They appear in the form of diagrams with their names and descriptions, overlapping good resolution satellite images. To publicize the possibility of voting we used social media to send the link. In the case study we opted for Facebook, through paid promotion per day, targeted at users who were located in a territorial delimitation, defined by the area of influence of Faenza. Thus, during a period of one week, people located in the Faenza region received the advertisement of the vote on Facebook and were able to participate voting and including comments on the platform. (Fig. 10).

More research is needed on the role and quality of this type of consultation, since there are phenomena of participation in social media that are already being studied as limiters or challenges to be considered in the consultations.

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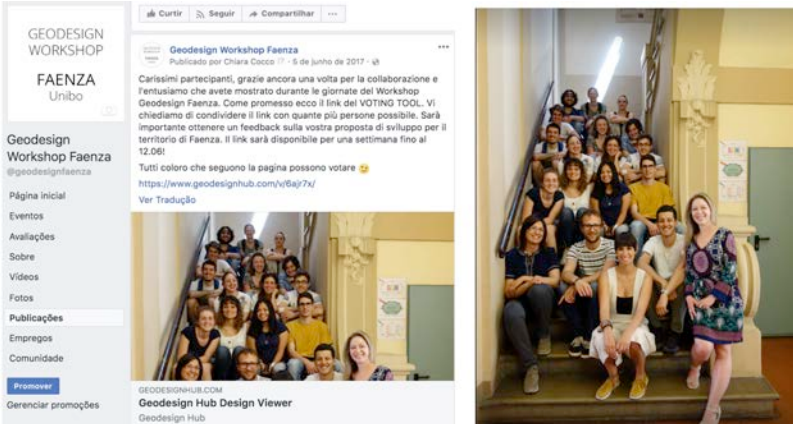

Fig. 10 The advertisement to take part and the voting process

4 THE PRODUCTION OF EVALUATION MAPS AS A SUPPORT FOR THE CO-CREATION OF IDEAS

The use of web-based applications, as described in the previous item, was extremely important to get opinions about citizens' values and expectations, to broaden the participants' understanding about the area, to involve participants in different stages of judgment of values, and to give support to the proposition of ideas and construction of agreements. However, there is a stage that is under the responsibility of the technical staff and that can be favored by this listening to the citizens, who can act more safely while contemplating both expert knowledge and the opinions of people of the place.

By listening to the main values and what should be observed better in each system, the technicians can contribute with their knowledge and responsibilities in indicating restrictions and possibilities, but can also consider characteristics that are values for the local community. This is done through the technical elaboration of the evaluation maps, which are the references from which the participants of the Geodesign workshop build their ideas. (Fig. 11).

In the preparation of the evaluation maps, the technician must be aware of the need to combine variables, which are the main components indicated by him due to his knowledge and also by the local people as their opinion about what is important for characterization of the territory, by theme or system. Combinations can happen by multi-criteria analysis based on weighted sum or combinatorial analysis to identify territorial coincidences.

The multi-criteria analysis by weight of evidence, which uses weighted sum algebra, aims to generate an index, classifying the area from the lowest to the highest potential for some activity or proposal. Combinatorial analysis identifies all possible combinations of occurrences, without the risk of making the initial information disappear, being possible to highlighting some element that must remain significant apart from the other layers of information.

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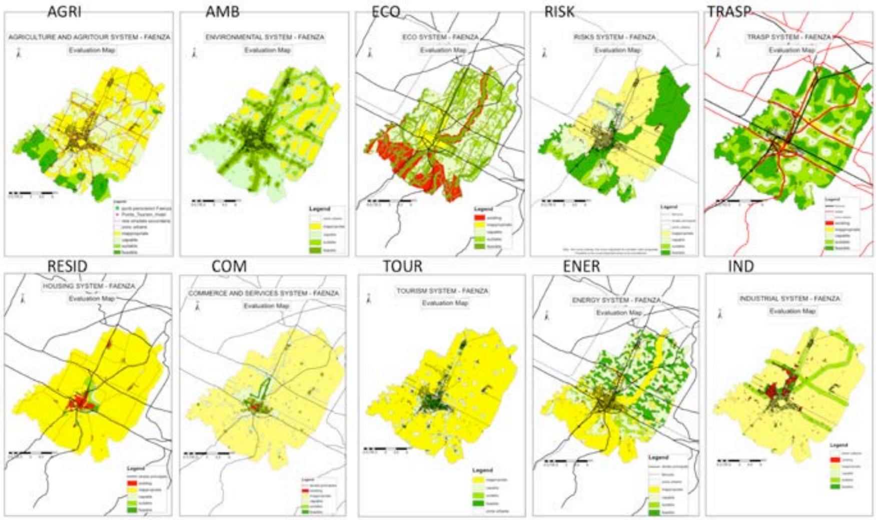

Fig. 11 Collection of Evaluation Maps – case study of Faenza

In the following example, it should be noted that in the case of multicriteria analysis based on weighted sum, an index is created and the specific presence of each component is no longer identified. In the case of combinatorial analysis, the presence of each occurrence is still recorded, being possible to identify some element that must remain highlighted. (Fig. 12).

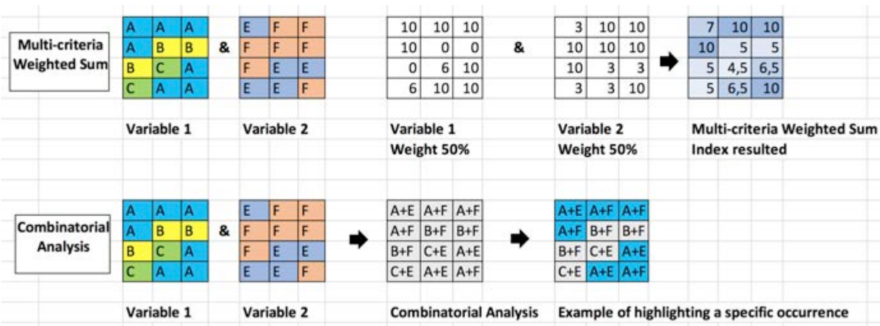

Fig. 12 Multi-criteria Analysis and Combinatorial Analysis

4.1 EXAMPLE OF THE COMPOSITION OF THE EVALUATION MAP USING MULTI-CRITERIA WEIGHTED SUM

In the analysis of multi-criteria it is necessary to define the main variables that will compose an index of potential for some transformation. In the illustrated example, the variables selected to analyze areas indicated for environmental recovery. They were about water resources, fragilities due to the use of chemical products and the generation of waste, fragilities related to noise pollution and fragilities related to

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air pollution. The variables were combined by similar weight and resulted in a map that is an index of interest to environmental recovery intervention, to propose projects or policies for this system. (Fig. 13).

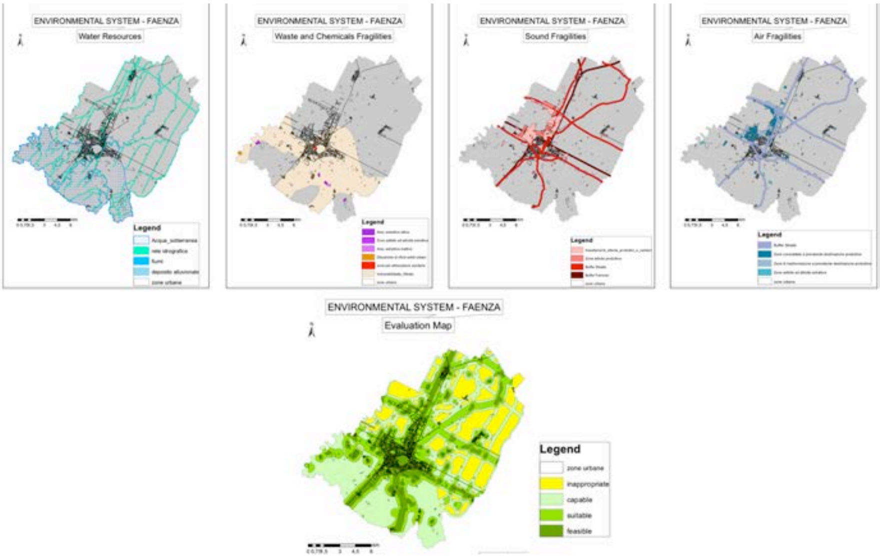

Fig. 13 Multi-criteria Weighted Sum to compose and index of priorities to propose projects or policies to face environmental fragilities

4.2 EXAMPLE OF THE COMPOSITION OF THE EVALUATION MAP USING COMBINATORIAL ANALYSIS

In the combinatorial analysis it is also necessary to define the main variables that will compose a synthesis map that highlights the most important occurrences to be considered as reference for the proposition of projects and policies of a theme. In the selected example the objective was to construct a risk map, indicating all the places where there was some risk, so that solutions could be proposed.

If multi-criteria analysis were employed, a lot of information could be lost because the weighted average would highlight only those areas where all or most of the risks appeared. In combinatorial analysis, what was important in each map is maintained and appears in the final map as a priority area of intervention. (Fig. 14).

5 RESULTS AND DISCUSSION

The work presents itself as a contribution to the study of Geodesign, in which the objective is the co-creation of alternative futures for a territory. It was developed in an academic environment, with the objective of testing the effectiveness of web-based applications in all stages of the process, initially with the generation of digital natives, but the broader objective would be to create references so that the processes could also be used in other workshops.

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From the point of view of the tests with the participants of generation Y, it was verified that, as digital natives, they had no difficulty in using the web-based platforms and the applications proposed, and the fact that we opted for these media favored that they remained interested and very active throughout the whole process.

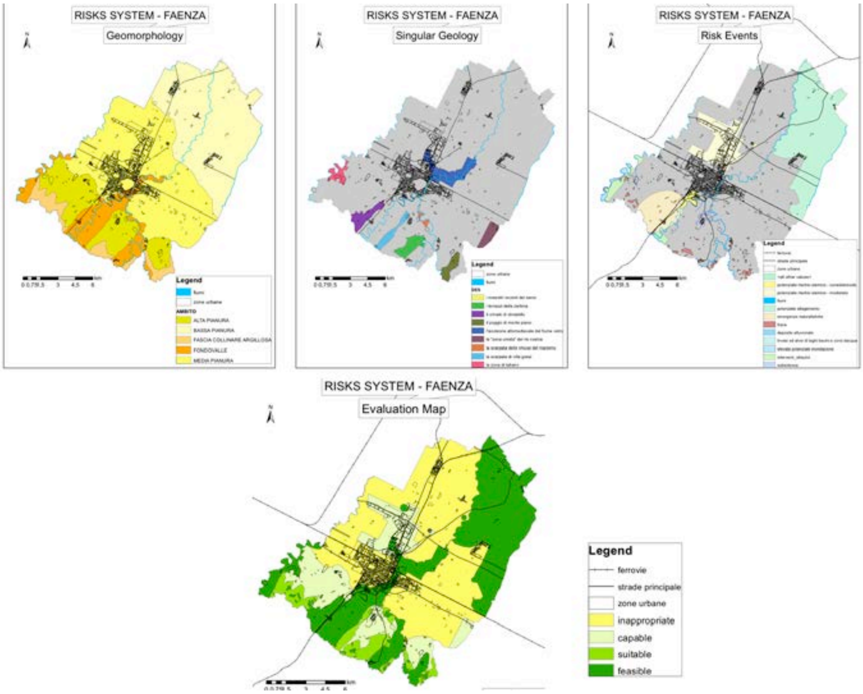

Fig. 14 Combinatorial Analysis to compose the spatial occurrence of elements and to highlight the most important ones to be considered. The risks to be faced are in the example

From the teaching point of view, the restricted number of course hours were sufficient for the learning process to take place, and for them to do the experiment with a robust and reproducible method they can use in other case studies in the future. The fact that we chose a real case study, with real data and a known territory favored the learning process and the interest.

Based on our experience, we started to use web-based applications in all other case studies developed in all stages of the Geodesign framework, in the pre-workshop phases, during and after the workshop, in propositional and evaluation steps. In traditional use of Geodesign, organizers perform various tasks before, during and after the workshop, in the following scheme (Fig. 15):

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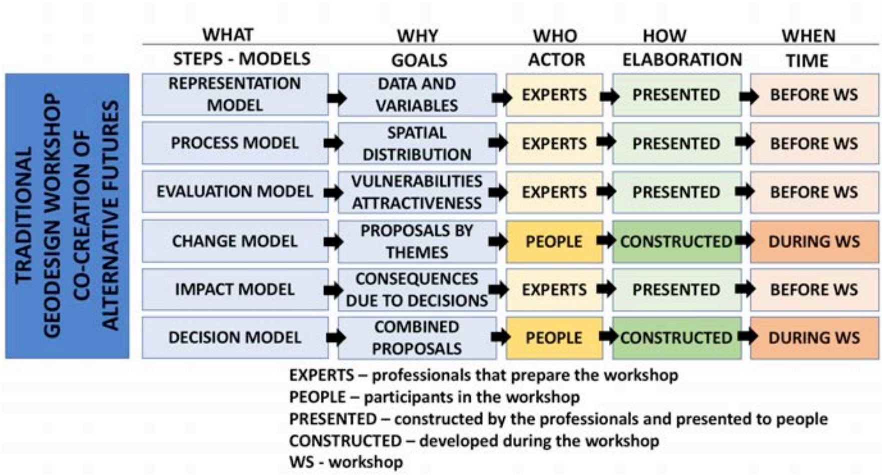

Fig. 15 Traditional scheme used in a Geodesign workshop, following the framework of Steinitz (2012). Activities according to the objectives, the people involved, the way and the moment they are presented or constructed by the participants or the organizers

To foster better understanding and involvement of participants, we proposed the use of web-based applications in all the steps of the framework. We present when, the goal to be achieved, who is going to use the application, if the results are going to be presented to the participants or if they are going to be constructed by them, and when the applications are going to be used according to the steps of the Geodesign experiment. The proposal follows the following scheme (Fig. 16):

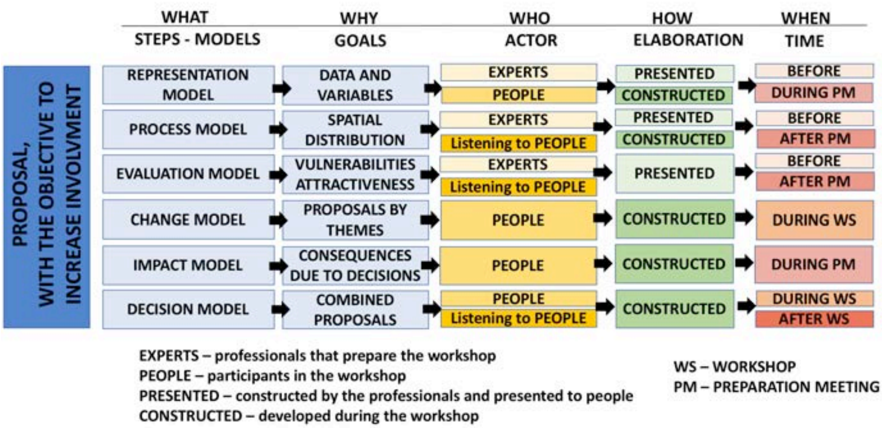

Fig. 16 Proposed scheme including web-based applications to foster better understanding and involvement of participants by broadening co-creating ideas. Activities according to the objectives, the people involved, the way and the moment they are presented or constructed by the participants or the organizers

According to each model, some web-based applications are proposed, and there are tasks to be done by the experts that organize the Geodesign experience, and tasks to be developed by the participants. The goal, in

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the models of representation, process and evaluation is to identify the genius loci of the place, to highlight the main characteristics of each system using cloud-words and to produce evaluation maps that represents the main expectations and values to be considered, for each system. (Fig. 17).

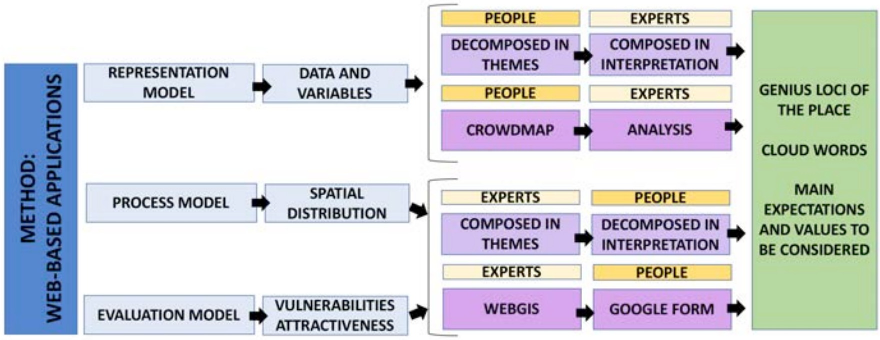

Fig. 17 Proposed scheme including web-based applications to foster better understanding and involvement of participants by broadening co-creating ideas. Geodesign framework activities steps and intentions or possibilities of using applications. Registration of actions by participants and by organizers, and results to be obtained. Stages of representation, process and evaluation

In addition to the stages of change, impact and decision models, there are tasks to be done by the expert technicians who organize the Geodesign experience and tasks to be developed by the participants. The web-based applications result in support for the construction of ideas to be proposed, in the classification of the probable impacts to be caused in each system from the proposals made, in the support to the co-creation of project ideas and policies for the area, and in the expanded vote on the acceptance of the proposals made. (Fig. 18).

The interest to get participants involved in all the steps of the preparing of the workshop has the goal to make them understand better what and why they are doing some tasks. While informing about the main characteristics of the place, promoting discussion about vulnerabilities and attractiveness, the applications and also educating people to analyze data, transforming them into information and with the possibility of constructing knowledge. People learn about the place, from the technical point of view, and also about how to read and interpret spatial data. The experiment a process of co-creation of ideas.

From the technical point of view, the organizers learn from people of the place about their values and expectations. They can decode collective values and transform them in designs that fits the people and the place. They have to do efforts to present information in accessible language, to create a dialogue with all the participants of the process. The more the invest on visualization tools, the better participants will be able to contribute in the co-design. The more they invest on web-based tools, the bigger the number of people that will be able to take part, and design thinking will be part of society, co-creating the common future of a group.

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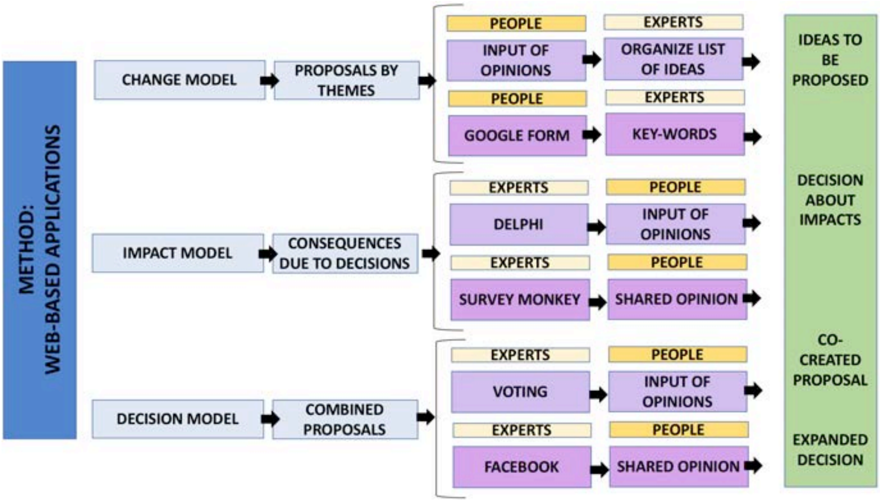

Fig. 18 Proposed scheme including web-based applications to foster better understanding and involvement of participants by broadening co-creating ideas. Geodesign framework activities steps and the intentions or possibilities of using applications. Definitions for the actions to be made by the participants and by the organizers, and expected results to be obtained. Stages about change, impact and decision models

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