PARTICIPATORY PLANNING PRACTICES BASED ON INTERACTIVE VISUALIZATION

Práticas de Planejamento Participativo Baseadas em Visualização Interativa

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ABSTRACT

The paper presents the study about the potential of the use of an interactive visualization tool, based on dynamic cartography, as resulting from the process of academic exercises on participatory planning. The case studies took place in 2015 in "Mirafiori Sud", a neighborhood of the city of Turin, Italy, and in "Pampulha", a district of Belo Horizonte, Brazil. In both cases, the interactive visualization of maps was used for information gathering, sharing information and knowledge production among different target audiences.

Keywords: Geovisualization, Participative Planning, Planning Support System.

RESUMO

O artigo apresenta o estudo sobre o potencial do uso de uma ferramenta de visualização interativa, com base em cartografia dinâmica, como resultado do processo de exercícios acadêmicos de planejamento participativo. Os estudos de caso ocorreram em 2015 em "Mirafiori Sud", um bairro da cidade de Turim, Itália, e na "Pampulha", região de Belo Horizonte, Brasil. Em ambos os casos, a visualização interativa de mapas foi usada para tomada de opiniões, compartilhamento de informações e produção de conhecimento entre diferentes públicos-alvo.

Palavras-chave: Geovisualização, Planejamento Participativo, Sistemas de Suporte ao Planejamento.

1. INTRODUCTION

In the development of digital spatial analysis tools, we observed a timeline in which the applications started with Desktop Mapping Tools (with the goal characteristics of the place and to locate them) and evolved to GIS (with the goal to promote the application of more complex spatial models combining variables and values) (COWEN, 1990). When a GIS is structured to use specific models and to answer to specific demands it can be classified as an Expert Information System (MOURA, 2003). In the evolution of technologies of geoinformation, we have a time line that goes from desktop mapping to GIS, from GIS to Expert Information System, and we must also highlight the hole of visualization based on dynamic cartography, what means the possibility to change parameters and get as result the new composition (MacEACHREN, 1994).

In the same way, with the advent of web platforms, we observed the development of tools based on Web Mapping (to favor queries) but also more complex tools destined to WebGIS (to favor the use of spatial models). On the other hand, when a WebGIS is developed to promote some specific uses, it can be considered a Web Expert Information System in the sense that it provides facilities to achieve specific uses. And, if it provides dynamic results, allowing the users to simulate alternatives of combination of variables and parameters, it`s a web based interactive visualization tool, to support opinion making.

The purpose of the paper is to present the role of visualization tools to support opinion making in urban planning, using case studies that demanded sharing decision about alternative futures in the different scales, such as neighborhood and district plans. To illustrate the discussions, two case studies were selected with the goal to test the potentialities of visualization based on an interactive visualization tool, a WebGIS tool with characteristics of a Web Expert Information System. The chosen tool has a set of applications that promote dynamic visualization of spatial analysis. It works as the definition of a Decision Support System (DSS) (SOL et al., 1987) and it can be adapted according to the main demands of each case study. The use of a DSS tool is an opportunity to discuss the importance of visualization tools to construct opinion making and to support decision making.

The case studies presented are related to an academic exercise and to a real participatory planning process. The case studies took place in 2015 in Mirafiori Sud neighborhood, Turin, Italy, and in Pampulha district, Belo Horizonte, Brazil.

2. RELATED WORKS

In the field of visualization, there is a specific branch dedicated to the visualization of spatial data, known as geovisualization. It finds its roots in cartography, but has developed along with computer science as a research field and application since the 1980s. In 1995 the International Cartographic Association (ICA) created a commission called the Commission on Visualization and Virtual Environments, later renamed Commission on Geovisualization, establishing geovisualization as the science that, by definition, studies the exploration and analysis of spatial information through interactive visual interfaces (PENSA, 2012).

The term "geographic visualization" (as well as the term "cartographic visualization") was first published in 1987 in a National Science Foundation report on visualization in scientific computing (MCCORMICK et al., 1987). According to MacEachren (2001), research and practice in geovisualization, however, have roots dating back at least a decade before 1987. This origin is related to a French edition of a book by Bertin, Berg and Scott (1981) that presented ideas of cartographic design and information to represent and explore data.

Early work on geo-visualization focused on: (i) the role of maps with dynamic-visual displays, dynamic cartography as prompts for scientific insights; (ii) the methods by which dynamic visual displays could influence cognitive processes of perception to facilitate scientific thinking (MACEACHREEN et al., 2004).

As a concept, geovisualization, according to MacEachren et al. (2004) is both a process aimed at leveraging data resources to meet the scientific and social needs of a field of research that develops visual methods, as well as a tool to support a wide range of data applications

geospatial. In summary, as pointed out by MacEachren et al. (2004), geovisualization can satisfy four main objectives: presentation, synthesis, analysis and exploitation of data. As visualization, geovisualization can also be considered a means of communication between the parties involved in the planning processes, but also an instrument to build a path to knowledge and stimulate dialogue between the parties involved in the processes (VAN DEN BRINK et al., 2007).

Geovisualization favors support for planning decisions, since it can: (i) collaborate in decoding, as it is a means of visual translation of numbers and texts; (ii) collaborate in the organization of connections between the different elements (actors, actions and processes); (iii) allow the information to be located, understood, organized and investigated; (iv) favor the exploitation of data and its imperceptible connections.

An important objective of the GeoVisual Analytical Support for Spatial Decision Support is that it gives special attention to the geographical complexities or more generally of the physical space, to support the work of several actors with different roles, competencies, capacities and interests, and for integrating innovative computational technologies into traditional human decision-making practices (ANDRIENKO et al., 2007). In this sense, according to Masala and Pensa (2014), the objectives of geovisualization are in their use as a planning tool, since it is related to overcoming the representation of pure data, and can contribute to deepen the understanding of the relationships between the data.

In the context of the relationships between geo-visualization and planning processes, it should be bared in mind that a very diverse number of actors may be involved in decision-making and opinion-taking processes. Andrienko et al. (2007) explain that differences among actors may not only be personal but implied by their functions in planning processes to be still different in many other respects, including domain and depth of experience, educational level, knowledge of information technology and experience in the use of maps, graphs and information technologies in a more general way (ANDRIENKO et al., 2007).

Geovisualization support tools should help analysts in planning processes to get input from stakeholders about decision criteria, sources of information and opinions, for example. Such tools should also include the iterative process, considering the reverse path, where analysts give feedback to the stakeholder group. For Andrienko et al. (2007), the geovisualization support tool should therefore contribute to the analysis of the problem in a global way, considering inputs, outputs, interactions and iterations, generation and evaluation of options and solutions.

Andrienko et al. (2007) argue that, traditionally, geovisualization and information visualization have focused on the development of methods and tools to support the discovery of patterns and relationships in data. However, they draw attention to the fact that it is crucial that decisions are based on assumptions validated by the stakeholder group. For this, they point out that it is necessary to find ways of articulation between the exploratory visualization, the validation of patterns and the relations detected between the data through the visualization. Andrienko et al. (2007) suggest as a way, for example, the formatting of tools that give immediate visual responses to inputs. In this context, the importance of visualizing real-time spatialized information as the main communication need is highlighted, which should be as efficient as possible to facilitate the understanding of impacts and changes in planning processes.

Although the use of the Geographic Information System (GIS) already has full conditions of implantation and national use in Brazil, due to the existence of free software and in Portuguese and some collections of data of free access, the country is not yet a user of Planning and Decision Support Systems based on Spatial Decision Support Systems (SDSS). Considering that such systems favor the handling of information in a systemic way and have significant communication potential, it is one of the main justifications for this research: to investigate methodological procedures that may contribute to the reduction of the aforementioned fragility of Brazilian planning.

In the case studies in particular, one can say that for the neighborhood of Mirafiori Sud the process was to support the taking of opinions

and support for decision making, since the municipality wanted to hear representatives of society for general decisions, from which will develop specific projects. In the Pampulha case study, which was an academic exercise, it was a support for the taking of opinions that aimed to instrumentalize planners in order to understand "if-then" questions, that is: by visualization process and dynamic cartography perceive the impact of choice of some variables and changes in the parameters of these variables when making an urban plan in which preferences are chosen and hierarchized actions (represented by thematic variables).

Still in relation to tools to support visualization and consequently participation, it is pointed out that the diversity of tasks, stages and scales of planning application should be considered, as demonstrated by the several case studies discussed in this thesis. Visualization research and planning support tools that use it are highly interdisciplinary, and their developments may involve quite diverse areas and their intercessions, such as: prospecting, selection, exploration, management and merging of data; the field of statistics; the science of cognition and perception, among others. The case study presented here is only a cut within this broad field.

3. TOOLS AND METHODS

DSS tools are focused on the visualization of information and on knowledge sharing as a media for increasing social inclusion in planning processes. When it is associated to Spatialization in WebGIS platform it can be classified as a Decision Support System (SDSS). SDSS "serves as the core processor in the decision-making process of the planning support instruments" (WANG; SHEN & TANG, 2014, p. 239).

The use of a SDSS tool aims the support of decision-making processes for urban and regional planning, combining the georeferenced databases to a wide range of multi-dimensional visualizations. A SDSS tool shows data collected for the decision-making process to provide the visualization of scenarios and to facilitate the discussions and acquisition of information, aiming to overcome the differences between the stakeholders (PENSA & MASALA, 2014).

The SDSS tool chosen for the case studies was InViTo. InViTo (Interactive Visualization Tool) has been tested in several European projects since 2010, having support and contribution of specialists from several countries and different capabilities. In accordance with Pensa and Masala (2014), the tool is capable of: enabling the projects management, performing land and urban assessments, generating graphics, managing databases, in addition of performing other related functions and tasks depending on the context to be used for. (Figure 1).
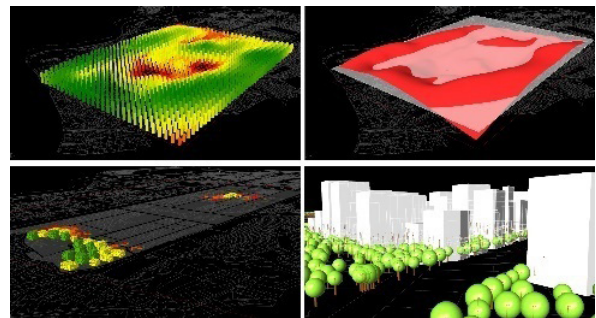

Fig. 1– Skopje case study. Source: Pensa; Masala, Marina, (2013, p.146).

It is worth mentioning that InViTo was selected for the case studies, but the dynamics could have been realized with any other application that favors dynamic mapping, based on visualization as support for opinion making and for decision making. Some examples are the applications that Torrens (2012, p. 435-436) call as "geosimulation", that is based on "proximity-adjusted preferences" (LIGMANN-ZIELINSKA; JANKOWSKI, 2012, p. 169). Geosimulation can be provided by the user, that changes values, variables and parameters in combinatory analysis, but also by mathematical models that are programmed to achieve an objective function, defined by the user.

The SDSS methodology is mainly visual and intends to offer capability in organizing, filtering and exploring data and the respective imperceptible correlations. A tool of this kind involves some considerations in the provided support: (i) it considers the success of a decision-making process strongly depends on the possibilities of communication among the involved parts; (ii) assumes that a decision-making process is only effective if the participants achieve a high level of knowledge for their choices (MASALA; PENSA, 2014).

The SDSS application uses interactive maps, that work with spatial analysis and combination of variables. It`s based on the logic of "if-then". For example: when performing the combination of data in multicriteria analysis, the user can choose the variables to be combined, and the relative importance of each variable, getting as a result the classification of the area according to suitability to the subject of investigation. It presents some facilities of a Geographic Information System (GIS), more specifically WebGIS, associated to different types of inputs, as spreadsheets and vector files. (Figure 2).
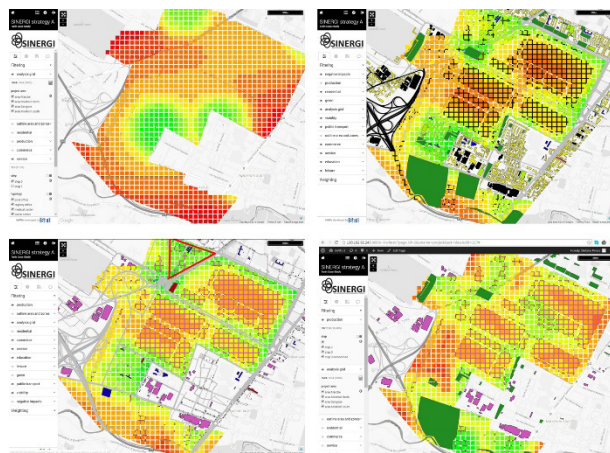

Fig. 2– InViTo weighting section interface used during the SINERGI workshop in Turin. Legend: Green color indicates height suitability, yellow is medium suitability and red is low suitability to the subject of investigation. Source: InViTo print screen, (Turin, June 30 to July 2, 2015).

SDSS tools can provide several data visualization opportunities (MASALA & PENSA, 2014). For instance, it simultaneously combines several layers on the map. Each layer can be visually customized in colors and geometry thickness according to specific attributes, whereas the background map can change in style or can be switched off to improve the readability of the map. The expectation for the introduction of this sort of application sets is to "offer a range of possibilities for users to improve their analytical skills and enhancing the discussion" (PENSA et al., 2016, p. 193).

4. CONSIDERATIONS ON CASE STUDIES APPLICATION AREAS

Pampulha, in Belo Horizonte, Brazil, and Mirafiori Sud, in Turin, Italy, present several critical issues that motivate the choice to use a tool as SDSS

to support opinion making and decision-making process. Both case studies have in common the overlapping of historical, architectural and urban interests. In addition, both areas are under pressure of urban transformation.

4.1 Mirafiori Sud, Turin

The Mirafiori Sud neighborhood is in the Southern part of the City of Turin, Italy (Figure 3 and Figure 4). The initial setting dates to 1585, when the King Carlo Emanuele I started the building of Mirafiori Castle (CITTÀ DI TORINO, 2009).
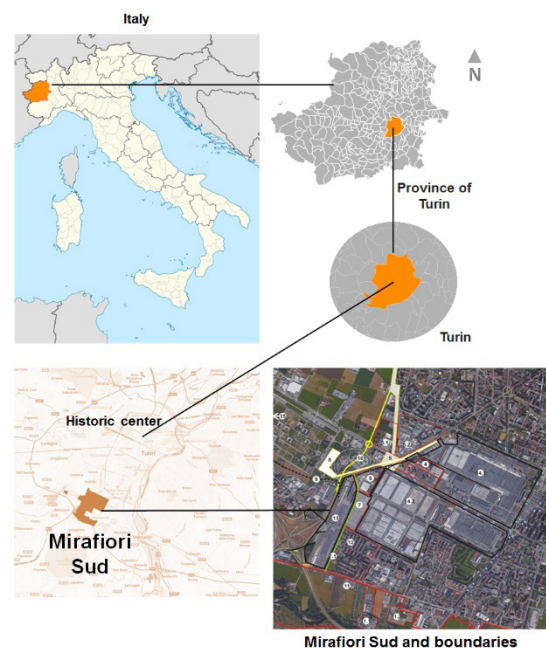

Fig. 3 – Localization of Mirafiori Sud. Source: produced by the authors from TUBS [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0) or GFDL (http://www.gnu.org/copyleft/fdl.html)]
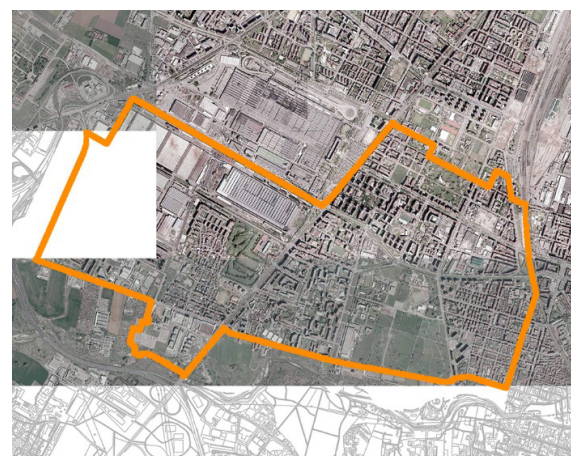

Fig. 4 – Satellite view from Mirafiori Sud (Boundaries in orange, approximate Area of 8,000 m²). Source: Adapted from Torino e Commercio (2007).

However, the most significant phase of the occupation and development of Mirafiori Sud is related to the 20th Century, when the city of Turin faced an expressive urban growth due to the first period of the industrialization process. With the risk of becoming a very impacted city resulted from industrialization process, in 1928, the National Authority decided to build this new area in the south of Turin, based in the logic of "Garden City". The urban design was based on zoning sectors and the main typology proposed in this occupation plan was related to single-family homes surrounded by a private garden, the "villas". Also as part of modern urban planning, the sectors included a sanitary logic, defining a block to receive the hospital ("città della salute"). According to Ramondetti (2016, p. 74) "the territory of Mirafiori was chosen because of its position, close to different natural areas and not far from the center of Turin".

Approximately one decade after this phase, the FIAT factory (Fabbrica Italiana Automobili Torino) was opened in Mirafiori Sud in 1939, to solve the lack of capacity at Lingotto factory plant. During the following decades, the FIAT plant expanded several times and the Mirafiori Sud area was affected by a massive urban growth and the consequent creation of several working-class neighborhoods which characterize this portion of the city to this date. Therefore, the small group of villas was gradually surrounded by social housing (RAMONDETTI, 2016) (Figure 5 and Figure 6).

Fig.5 – Partial aerial view of Mirafiori Sud: FIAT. Source: Torino Nuova Economia (2015)

Fig.6– Ensemble of social housing in Mirafiori Sud. Source: L'Espresso (2015).

The FIAT plant implementation, its expansion and the changes along the years was certainly a significant event that affected the whole area of Mirafiori Sud, and from the city of Turin itself, from several points of view. Such changes include social, economic environmental and urban issues of the city of Turin that, in large and small scale, have been associated to the "health issues" of Mirafiori Sud (ARMANDO, 2015, p. 36).

According to Armando (2015, p. 36), this part of southern Turin suburbs represents "an emblematic case of how the European metropolitan peripheries are facing a new kind of problems in the last years". These problems are especially related to the low occupational interest and the low value of the region in relation to the market. Thus, choosing Mirafiori Sud as case study is justified by the concern with "[...] the possibility of exploiting and recycling many local resources that, at present time, are underestimated by the contemporary urban policies" (ARMANDO, 2015, p. 36).

In the case study of Turin, the goal was to apply visualization tools to discuss, with people from the place and different sectors of society, the possible alternative futures to the area. It was a dynamic cartography representation, a web-based expert information system, to give support to opinion making, but also to arrive to decision making.

4.2 Pampulha, Belo Horizonte

Pampulha (Figure 7) was the first planned district designed according to modern principles in architecture and urban planning in Brazil, and one of the first designs of Oscar Niemeyer. Niemeyer once explained it represented the beginning of the ideas developed some years later in Brasilia planning. Due to the beauty and originality of the architecture, for its integration to the landscape, Pampulha was recognized as a World Heritage by UNESCO in 2016.

Fig.7– Localization of Pampulha. Source: IBGE and Prodabel.

The birth of Pampulha occurred in the 1940's, when Juscelino Kubitschek took over the City Hall executing an administration that "prioritized the modernization of the urban infrastructure and the creation of new districts far from the Capital's central areas" (BESSA & ÁLVARES, 2010, p. 3). Among those there was Pampulha, built 15 km far from downtown.

The creation of a leisure complex in Belo Horizonte was an idea that translated the interest of convert Pampulha area in a modern symbol for the city, around the artificial lake built in 1938 to assure the municipal water supply (BELO HORIZONTE, 2014, p. 144). Pampulha Architectural Complex was composed by the Casino, the San Francisco Church, the Yacht Golf Club (current "Iate Tênis Clube") and the ballroom ("Casa do Baile") and was built around the lake shore mentioned earlier (Figure 8, Figure 9 and Figure 10).
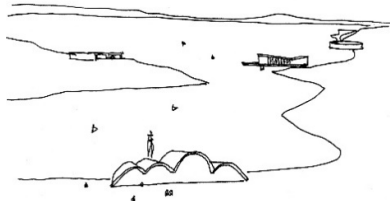

Fig.8 – Oscar Niemeyer's sketch. Source: Belo Horizonte (2014, p. 59).

Fig.9 –The architecture of Niemeyer. Source: Geoproea, UFMG, drone capture (2017).

Fig.10 – Green landscape overview. Source: Belo Horizonte (2014, p. 68)

In the 1960's and 1970's, the middle and lower-income class also begun to move to Pampulha areas, formerly used as old farms (RIBEIRO, 2011).

During the last four decades, the enhancing of the occupation of several areas was observed, and the landscape of Pampulha district started to face challenges related to potential land use attracted by its good infrastructures and position in relation to downtown and due to the quality of life, resulting in conflicts of interests.

Beyond the identity of its modern characteristics there are also other reasons to consider Pampulha an area of interest for urban studies: availability of vacant lots, the presence of significant vegetation cover; water resources and natural bed creeks; mix in the land use regarding to density and income (PRÁXIS PROJETOS E CONSULTORIA, 2011).

Considering the residential typologies, the region presents: single-family houses, clusters of high density population and verticalization (Fig.11) and even occupation of geotechnical risk areas (PRÁXIS PROJETOS E CONSULTORIA, 2011).

Fig.11 – High density area in Castelo neighborhood. Source: Práxis Projetos e Consultoria (2011, p. 14).

In Pampulha there are also big structures, like the Campus of the Federal University of Minas Gerais, the regional airport, the stadiums of Mineirão and Mineirinho, the sport center of the UFMG, the city zoo and a military area. The main urban planning demands for the area are related to the aspects of improving public transport and accessibility, preserving environmental aspects in green and blue infrastructure, with emphasis in the recovery of the Pampulha lake (PRÁXIS PROJETOS E CONSULTORIA, 2011).

Due to the fact that it is a region characterized by different land uses and critical layers, it is

important to study methodologies and tools that might contribute for urban planning process for its territory. Even as academic research, it`s a contribution to promote discussion, based on visualization tools and dynamic cartography, to support opinion making that, one day, can be used as support to decision making.

5. MIRAFIORI SUD CASE STUDY

This section presents the case study of the use of interactive visualization tool, an SDSS, in a participatory planning process, that was a part the SINERGI Project, an "Europe for Citizens" program, from 30 June to 2 July of 2016.

5.1 SINERGI Project

The Social Integration through Urban Growth Strategies (SINERGI) project is focused on establishing a network of cooperation among city administrations, experts and civic organizations by means of a collaborative platform in which the main theme is the socially inclusive urban growth within different social sciences fields. One of the main focuses of the project is to identify, analyze and reflect on issues of integrated urban management with a high level of social inclusion, through new approaches that include tools for urban planning with citizen participation (FRASSOLDATI, 2016).

The fundamental basis of SINERGI project is the need to include citizens' participation, and they decided for digital tools to achieve that objective and to support the construction of different scenarios, resulting in different solutions. The expectation is that such diversity of answers arising from the participation, provides the generation of new knowledge about urban complexity in a more holistic perspective. It is also expected that the experiences can contribute to the participants' awareness of their possibilities and responsibilities, to play an integral role in the democratic life of the European Union (SINERGI, 2015).

5.2 InViTo technical setup for Turin case study

The interface of the chosen SDSS tool for this participatory planning case study, InViTo, is organized on two main frames: a dynamic map on central-right side and a menu on the left side which allows users to explore data and interacting with information (Fig. 12).
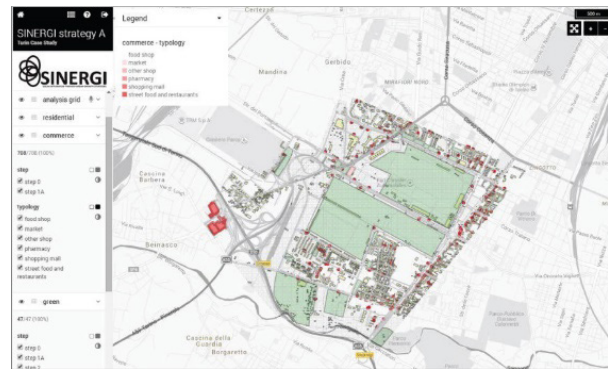

Fig.12 – Front screen of the SINERGI Project configuration: tools.

The tool map weighting section enables the sum and weighting of maps through a multicriteria analysis. The sliders in the menu allow users to set the weight of each map with regards to their objectives, while the map frame displays the map overlapping, providing the visual result on a location-based analysis. Such possibility is useful, for instance, for analyzing the main variables of a project and spatially visualizing the effect of specific decisions or policies (Figure 13 and Figure 14)

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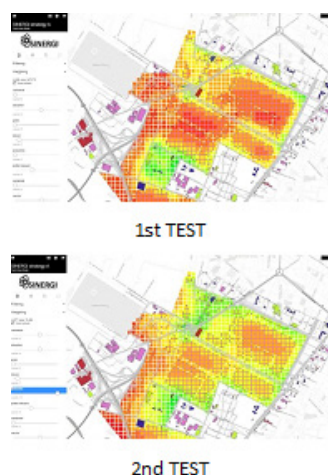Fig. 13 – Print screen of InViTo weighting section.

Fig.14 – Weighting section on the front interface of InViTo.

At the end of the weighting process, the maps show the spatial effect of the selected layers depending on the assigned weights. The weights variation in the left side menu change the effect visualized through a traffic light gradient on the right-side map. According to the assigned weights the map shows the optimal areas in green, the average interest areas in yellow and the areas that are not in accordance in red (Figure 14).

5.3 Preparing the workshop

The first thematic SINERGI workshop was held in Skopje (Macedonia), in December 2014, while the second thematic meeting was in Turin, six months later. Both seminaries were supported by the use of a web-based SDSS, planned to promote visualization and to result in dynamic cartography and "assist the participants in the analysis, exploration and visualization of data related to the areas and the respective context" (PENSA et al., 2016, p. 193).

During workshops, either in Skopje as in Turin, the groups of participants were quite diverse and composed by many actors, such as students, professors, municipal managers, technicians and social representatives (Figure 15 and Figure 16).
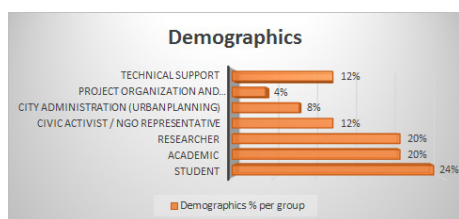

Fig. 15 – Data about the participants in SINERGI workshop in Turin. Source: Marina (2015).
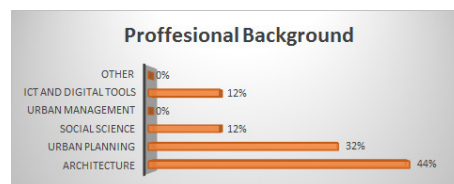

Fig.16– Data about professional background of participants in SINERGI workshop in Turin. Source: Marina (2015).

The preparation of the Second thematic workshop on the SINERGI Project (Turin, June 30rd to July 2nd, 2015) started months before the workshop itself. Turin workshop started from the outcomes of the first thematic SINERGI workshop held in Skopje. It was based on an agreement between Politecnico di Torino, the Metropolitan Urban Center and the City of Turin and the research team from SiTI.

The focus of the workshop was the discussion on future scenarios for the neighborhood of Mirafiori Sud, Turin. The workshop agenda included the visit to the area and meetings with the local associations and the parts responsible for the projects foreseen for the old industrial areas and brown fields. These meetings are part of the working strategy of the SINERGI, aiming to consider the possible changing scenarios for the assessed outline, considering the several backgrounds.

The area particularities have strongly affected the choice of the scenarios to be developed during the workshop, as well as influenced the manner to set and use SDSS tool to comply with the planned tasks. For this reason, before the workshop was held, a series of discussions took place among the members of organizing teams, in order to outline the possibilities and opportunities given by the use of interactive maps designed to facilitate and improve the interface between information and actors involved in the participatory planning process.

To provide as much data as possible to the participants, organizing teams produced several geographic data sets. These sets included variables related to the area, such as residential buildings, commercial business, urban mobility, public transport networks, green areas, production activities, services and facilities for health and leisure. Furthermore, data preparation required

the translation of a large amount of terms, from the original Italian terms into English, as required by the project that included actors with different nationalities.

5.4 Outputs analysis and visualization

On the first day of the workshop, the participants were informed about the use of the tool and about outputs expected from InViTo. They were divided into three groups that worked separately to address the three different scenarios of alternative futures for the case study area, as seen bellow:

- Scenario 1: shopping mall and commercial strategy;

- Scenario 2: new underground line and transport networks strategy;

- Scenario 3: innovative technology and Research and Development strategy.

During the second day, the SDSS tool InViTo was used by the groups for the weighting of the presence of specific variables on the study area and to understand the effect of such variables on the neighborhood. Each group was assisted by two researchers, who conducted the use of the tool to provide support in preparing the maps, and they acted as facilitators do draw ideas using GIS tools. Their participation, either technical and analytical, lead the actors to compare their choices according to consequent effects on the area, and to stimulate discussions and debates (Figure 17). In this way, the tool improved the social inclusion, enabling all the actors to be able to express their opinions and share knowledge supported by a visual interface.
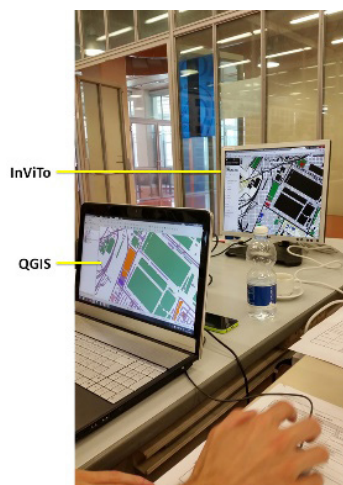

Fig. 17 – QGIS tool support.

During the workshop, analogic support tools (printed maps and papers to draw) were also provided to improve the discussions (Figure 18).
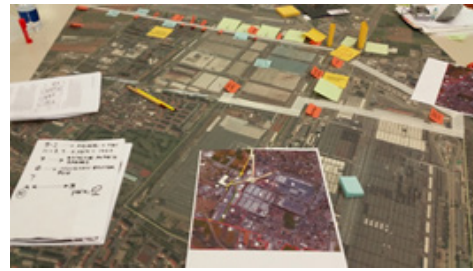

Fig. 18 – Supporting material for discussions.

Using SDSS interactive maps, actors produced suitability maps for different land uses as a starting point. To visualize and register step by step the study area changes a methodology was used, as follows:

(i)   Approaching the territory in relation to the strategy perspective;

(ii)   Weighting spatial elements based on the group preferences;

(iii) Deciding on the actions to be undertaken;

(iv) Input the planning solutions to InViTo, in accordance with the temporal sequence of the project strategy.

Using these steps, the groups could generate their own assessment and to visually share ideas on what to do (Figure 19).
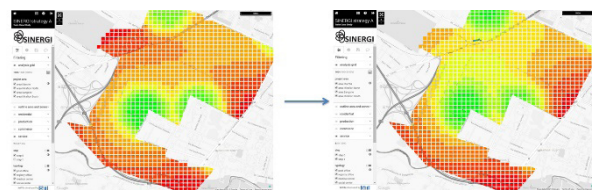

Fig. 19 – Comparison between the result of initial weighting (left) and the situation after revision of the project (right). Source: Workshop slides.

The SDSS tool was also useful during this phase as a base to the participants for suggesting new planning decisions, providing real time answers for "what if" questions and showing the effects of their decisions in real time. In this way, the tool provided a support to achieve the production of a shared option for future development based on collective interests and the agreement among the different involved actors (Figure 20).

Fig. 20 – Use of InViTo during the planning and decision-making session of the workshop.

The workshop was closed with a round of public discussions and lectures on the results. Such stage was quite rich, and several points have been debated highlighting pro and cons of the process and suggesting possible technical improvements for the methodology and for future workshops.

5.5 Analysis of results achieved in Mirafiori Sud case study

During the thematic workshop within the SINERGI project, InViTo showed to be a user-friendly Decision Support System (DSS) which uses the base of a WebGIS platform, but providing expert tools prepared to specific demands.

Regarding to data spatialization, the use of a SDSS tools provided the opportunity to explore role of giving emphasis to some urban planning decisions, as deciding about the importance of each variable that represents policies, and getting as results different scenarios. Such capability is particularly interesting because it might enable the planning of policies both based on the assessment of general and specific values and behaviors, to better comply with the local demands.

Regarding the methodology, the proposed strategy for the workshop was quite successful and produced at least two different types of development: (i) one group built a masterplan based on a progressive preparation using the SDSS tool to test, step by step, the intended strategy; (ii) another group had already started the process with a predesigned masterplan using the tool to decompose and test its parts.

Still mentioning the methodology and the use of the tool, the participants achieved the production of different outputs. Of course, such process was much more productive after each of

the groups was instructed in detail on the digital tool used. In this case, the presence of facilitating technicians was proved as fundamental.

Another improvement regarding the methodology applied in Turin was the record of refused and not used options for each group's strategy. In a real case study, and not only for academic purposes, this kind of approach is significant for recording the process and providing the basis for unfolding other discussions.

Considering the increase of the debate and participation as a goal of the workshop, the use of a SDSS tool contributed enabling discussions among actors with different nationality and expertise. The tool contributed so that people could share their opinions within their groups and among groups, during the final session.

6. PAMPULHA CASE STUDY

The second workshop was held in August 2015 and was developed for academic purposes. It occurred in the School of Architecture of the Federal University of Minas Gerais (EA-UFMG). This second case study was presented to investigate the potential of a SDSS tool in visualizing data to support the decision-making process. The area selected for the case study was Pampulha (Figura 21).

Fig. 21 – Participants in the course 'Visualization and Usability of ICT in Urban Planning Processes'. Source: Authors' photo, registered on Aug. 20, 2015.

Pampulha case study was simpler than the one performed in Mirafiori Sud. In Turin, the SDSS tool has been used to detail the steps of a broader planning and to reach an urban design. In Pampulha, the tool was used only in one of the planning process steps, when the users carry out a multicriteria analysis for the variables combination to indicate potential areas for specific urban policies (Figure 22).

Seleção de variáveis	Gradação de pesos
Accessibility	100
Building Capacity	50
Commercial Index	50
Commercial potencial	0
Heritage	0
Housing	50
Income classes	0
Potential empty spaces	0
Real estate interest	100
Transport	100
Urban Dynamicity	50
Vegetation	0
Visual axes	0
Water and flooding	100

Step 1: Selecting Variables

Step 2: Record the weights given in the selection of variables in InViTo slider bars

Step 3: "Load" the variable weights to display

Step 4: Isolate the layer of optimal areas according to the weights chosen by the group

Fig. 22– Example of use of multicriteria analyzes by the Group 'Real Estate Interest'. Source: Adapted by the author of records of the Real Estate Interest Group.

The main purpose of the Pampulha case study was testing the use of a SDSS tool to facilitate visualization to support one phase of urban planning that is usually one of the first steps of the whole process: getting to an agreement on the significance of the variables and indicators, as support to opinion making, and the results can be considered in policies to be developed.

Starting from a set of initial maps, each group could choose the variables they believed were the most important to their objectives (for example the objective of representing housing programs) and they could test the effects of changing the importance of the variables. This experiment of changing the value of the variables in relation to the others is the base of a multicriteria analysis (MOURA, 2007, p. 2901) The output is the geovisualization of spatial results, a dynamic cartography, from the combination of variables chosen by the group, and a gradient that describes the level of suitability of the evaluated policy (Fig.22).

Participants were divided into three groups to carry out the exercise. Each group had to promote a purpose:

1. the housing development for the low-income class;

2. the improvement of the transport network;

3. the development of commerce and the real-estate dynamics.

The main demand of the workshop was to generate an overview map per group expressing the optimal areas (green), the average interest areas (yellow) and those of little interest (red) considering the specific purposes of each group.

A starting overview on multicriteria analysis using the web-based application was provided to all the groups. It was advised to all

participants to read the analysis scale the same way and, if possible, to compare the results at the end. The course was hold in English, the same language used in Mirafiori Sud project. Some parts of the workshop sections have been translated to Portuguese as necessary.

6.1 Case study practice: InViTo settings

InViTo Pampulha was setup for using the web tool (http://www.urbantoolbox.it/project/pampulha/). The data available in this version have been collected by specialists who structured the project and the maps system as a set of variables of interest for the purpose of the case study. It was up to the users testing the multi-criteria analysis weights possibilities.

With the goal to prepare technical users, the participants learned to generate and upload a layer. At this stage, each group was able, by means of ArcGIS, to compose and load a new layer in accordance with the respective study purpose.

The Steps to create this new layer were:
Step 1 – Define groups and purposes.
Step 2 – Set new layer in ArcGIS.
Step 3 – Convert the file format from

shapefile into JSON – JavaScript Object Notation (JSON, 2016) – aiming the maintenance of the open source data generation. It is worth mentioning the input for InViTo is provided by the combination of alphanumeric and georeferenced data, in this case performed by a shapefile with associated data (Projection WGS 1984 Web Mercator Auxiliary Sphere).

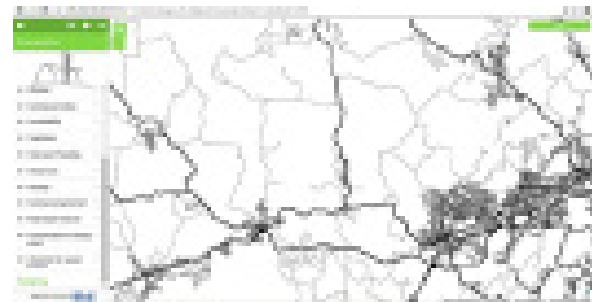Step 4 – Upload the layer to InViTo (Figure 23)

Fig. 23– Layers visualization of each group: names on the screen after the configuration. Source: InViTo.

Step 5 – Acknowledgement of the visualization tool and selection of the land areas for analysis and visualization (Figure 24).
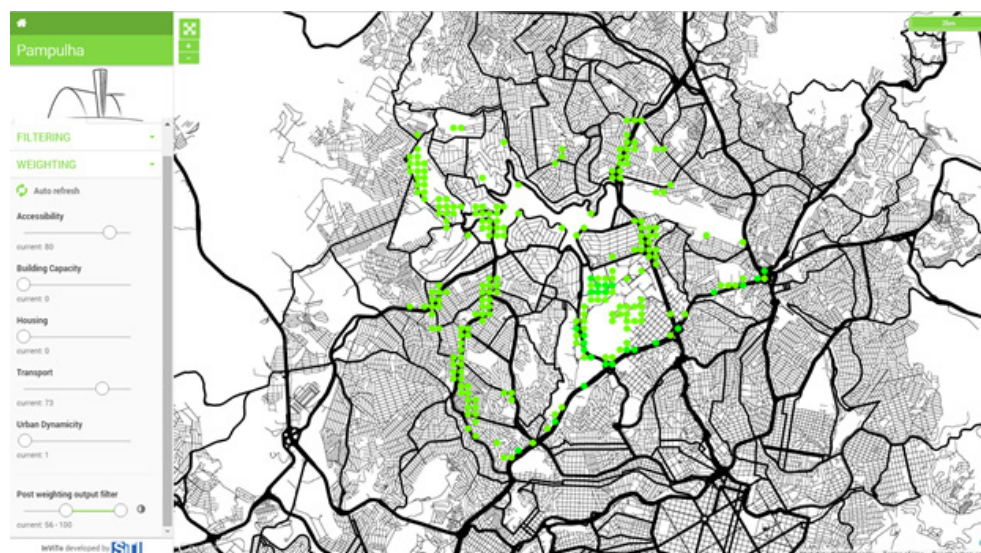

Fig. 24 – Visualization tools recognition in InViTo: use of the sliders sidebar. Source: InViTo

Step 6 – Acknowledging the tools for integration of variables by multi-criteria analysis using the filtering and respective scrollbars to control the weight assigned to each layer for the group. The variable weight set to zero means that the variable is not significant to the group (Figure 25).
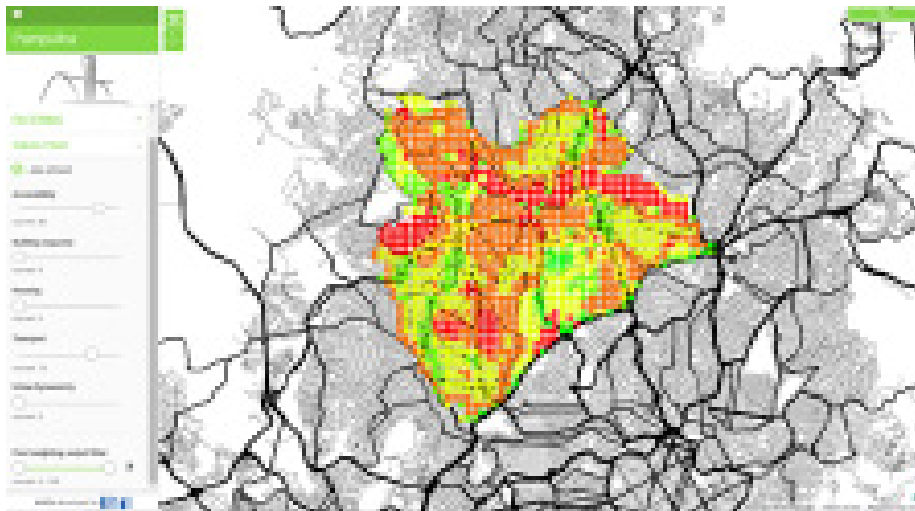
Fig. 25–Screen with scroll enabled. Source: InViTo

Step 7 – Preparation of multi-criteria analysis and selection of outputs visualization by setting thresholds (for example, higher value areas at the result, over 75% of the final result, etc.) or results visualization per land use type (for example, visualize results only for the areas of predominant average density land use, etc.). At this stage, the groups started the work from their own strategies and then defined the maps combinations that were significant for their purposes, combining the 14 maps in accordance with their purposes. The adjusting in accordance with the purposes of one group shows that some layers can be not significant for the project purpose, so those are equal to zero in the slider.

The used layers were divided into two groups and sliced by natural breaks under the classes: high (red color), middle (yellow) and low-class (green).

Each group had the opportunity of generating their own layer, constructed in a GIS application (ArcMap) to learn how to generate and upload layers to the system.

In general, there was the need to simplify the vertexes and polygons, depending on the density of data and size of the area. The topology is implicit in the used representation and the cell, in the present case, is 200m², indicating the approximation of the design scale and urban design (Figure 25 and Figure 26). Generalization in web-based systems is justified by some reasons: the conditions of the platform and the specific use of data. It`s important to work with more reduced files, as they are going to be distributed in the internet. But it`s also true that visualization and dynamic cartography have as goal to support opinion and decision making, what doesn't go on details, but just define policies that

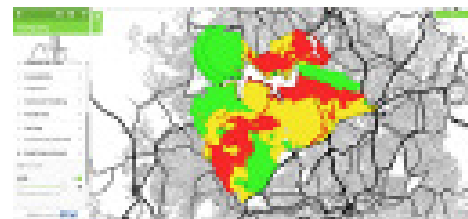are going to be better elaborated in projects by the technical group.

Fig. 26–Map produced in ArcGIS with simplification already inserted in InViTo. Legend: Green: high interest / Yellow: medium interest / Red: low interest. Source: InViTo.

6.2 Example of achieved results: Traders Group

To present an example about the use of the geosimulation tool from different groups, one of them was chosen, the Traders Group. They had as main purpose to prospect new business opportunities in the areas near the places to have the road system improved and the proximity of a new road to be open at the northwestern portion of the Pampulha district (Figure 27).

Fig. 27 – Pampulha limits, new road (in red) and roads that will receive improvements. Source: Adapted from ArcGIS.

Firstly, the group produced two maps using GIS tools, defining buffer areas around places in which a new road is planned to be constructed and in tracks that are planned to receive investments in improving existing connections. The buffer zones were related to the distance that would be covered considering different modalities of mobility, from walking to motorized mobility. In accordance with the group, this point is chosen due to the fact that the commercial activities attraction is fundamental for the mobility assessment, being considered one of the most significant for the commercial activities success (Figure 28).
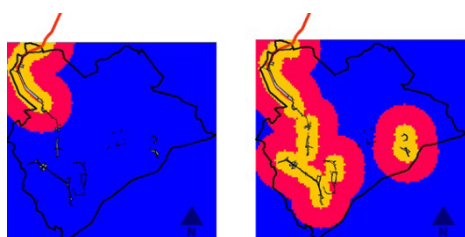

Fig. 28 – Euclidean distance of the new route and of the routes that will receive improvements. Source: Workshop meeting, 2015.

After preparing the maps in a GIS, they were used in the web-based platform SDSS to be combined and to allow the group to test the results of changing the relative importance of each variable. Using InViTo, the group performed the summary of the results by using the multicriteria analysis to combine three weighted layers: buffer zones of the new roads; general accessibility and capillarity along the district, and public transport network service. The group assigned the same weight to each of the in the multicriteria analysis (25% of significance) generating the following result (Figure 29).
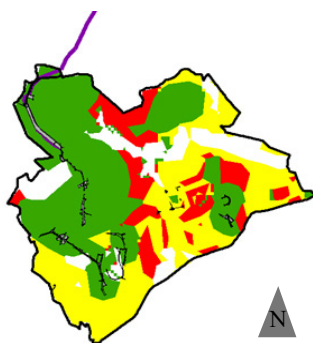

Fig. 29 – Final map of commercial potential. Legend: Green: high interest / Yellow: medium interest / Red: low interest. Source: Workshop meeting using InViTo Pampulha, 2015

The first combination, composed by maps about areas with good conditions to commerce and services activities, according to existing transport and accessibility to the place, was then combined to other variables. Also using InViTo, the group combined this first partial result with the maps of existing commercial areas, of empty areas, of real estate interests, urban dynamicity and visual axis. They could test different weights to each map, observing the results according to the changes. (Figure 29).

The meaning of simulating changes in weights is to understand the impact of developing one condition more than others, and its results in the territory. For example, if they decide that urban dynamicity is the most important variable, the result of multicriteria analysis will demonstrate where are the most interesting areas, in Pampulha, to the development of commerce and services, giving emphasis to this condition.

It`s possible to construct a map with values distributed all over the district, but also to see just those areas that are more interesting.

The map was generated by selecting only areas affected by the highest changing potential range, in accordance with the group variables (75 to 100%). Such areas, highlighted in green, match the areas with a higher accessibility level and a better transport network, in addition of being near the new road and to the road system improvements (Figure 30).
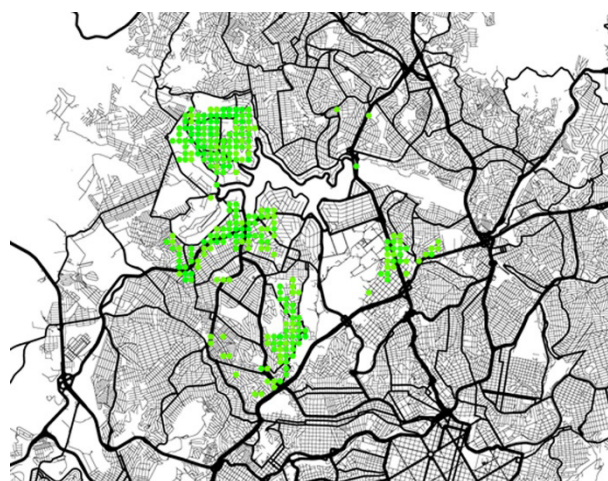

Fig. 30 – Final map of commercial potential. Source: Workshop meeting using InViTo Pampulha, 2015

6.3 Considerations on InViTo Pampulha case study

In Pampulha case study, the tool provided support for discussing possible urban policies. This means that each group could test and visualize the result of choosing a variable or a group of variables to receive investments and policies. On the other hand, in Mirafiori Sud case study the tool supported the projects' choice, enabling each group to define where to intervene and to which variable such intervention would be related.

The use of an SDSS tool, based on geovisualization and geosimulation, in Pampulha case study provided the possibility of exploring data by its respective spatialization (as well as in the Mirafiori Sud case) and contributed to stimulate discussions. During the execution, the tool provided, by means of heuristic processes, several conclusions, presenting great flexibility.

The records on the opinion shared by the workshop participants regarding the use of the SDSS tool in the Pampulha case study highlighted a generally positive opinion on the use of the tool.

7. FINAL CONSIDERATIONS

In Pampulha case study, the groups reported that the tool provided visualization possibilities of the maps in an accessible manner for all the involved participants. Part of the groups said the exercise created an environment for discussions on geovisualization and geosimulation, and enhanced the perspective of the use of interfaces based on geoprocessing by generating information in real time.

Regarding the technical part, the participants reported the versatile feature and that was significant to take part, at least partially, on the SDSS setting. This stage did not take place in Turin due to time issues and it was defended by some participants the desire of taking part of the tool back-end interface generation.

Still concerning the technical context, the comparison of the Mirafiori Sud case study and the Pampulha one, it is necessary to consider a basic difference: the database used Pampulha case was not entirely generated by open sources. It happened because in Brazil, the information access still requires a complex protocol, what was already overcome in Europe, due to Inspire Directive 2007/2/EC (EUROPEAN COMMUNITY, 2007). Such directive establishes the generation and full availability of spatial data infrastructure.

In Pampulha case study, the project counted on the significant collaboration of Prodabel/PBH, which provided the data by means of a cooperation agreement. In other Brazilian municipalities, it could be extremely hard to repeat the experience due to the lack of data.

The selected tools (GIS and SDSS) contributed in exploring data through visualization and spatialization. Considering the feedbacks on each case study, it can be noticed that the SDSS tool stimulated discussions among the actors who had different backgrounds, experiences and scholar activities. The geovisualization provided by the SDSS tool supported the actors to express and share their own ideas.

The mixed groups arrangement for the presented activities on the projects (Mirafiori Sud and Pampulha), composed by students (graduation and post-graduation), professionals from several areas (e.g. architecture, geography and transportation) and representatives of the public and private interest, greatly favored the discussions.

Since many participants are not yet familiar with certain vocabulary terms used in some discussions, warm-up sessions for clarification were helpful in examining methodological issues and thus expanding inclusion during workshops.

For the creation of the participation dynamics, the preparation of material instructions was fundamental, such as the one used in the Mirafiori Sud case study. As indicated by the feedbacks, such material facilitated the participatory processes.

For future investigations, regarding the class and sort of terms usually presented in the tools and maps, the use of expressions of "negative" meaning wouldn't sound good to the participants' ears, so it not recommended. The reason is that it could arise misunderstanding within the participating group.

In Brazil, geoinformation-technologies are still little explored by Architecture and Urban Design courses. The discussion on planning support systems such as SDSS, for instance, is still at the early stages. The same is noticed regarding the use of the methodologies and tools as support for public urban planning.

The case studies participants' feedbacks prove that, in general, in addition to the methodologies, there is a great interest in understanding the tools which can improve the participatory processes. Therefore, the visualization, according to the present case studies, can be considered as a facilitator, integrator and a support. The visualization enabled sharing existing and new ideas.

Considering Mirafiori Sud Case study, the SDSS tool could be considered as a support for a group's opinion, but not a reflection of a collective and an absolute truth. The synthesized maps generated by the tool translate the opinion of one group. Then, from the perspective of that particular group and according to the values of that group, such synthesis is "correct". However, if compared to the synthesis of other group (s) the synthesis may be partially incorrect and / or incomplete.

In the case of the Pampulha experience it was different because the groups have already started the workshop with different objectives (focus on housing, commerce, etc.) and in that situation, they experimented what is a technical decision when simulating the different impacts through calibration the tool. In Pampulha case the calibration was given by the combination of what each group thought about the place and what the tool made them understand about the place (a combination that resulted from the back-end preparation).

A criticism that is made here is that the tool does not give full support to the decision, but support the opinion. Although we have this critical vies, it can be said that the given support favored the approximation between the thinking of the technician and the thinking of the participant user. Thus, InViTo has the character of visualization to favor a choice that translates the opinion of a group, but also can create a bridge between technician and user. This takes place from the moment the user understands how the technical process is and understands how a territorial analysis is constructed.

While efforts are being made to make spatial information accessible to the Brazilian public in general (according to the principles of Spatial Data Infrastructure), there is still a long way to go in this direction. Obtaining a local database, as treated in Pampulha case presented here, was not completely obtained by open source, since in Brazil there is still a complex protocol for access to information, a step that has already been overcome a few years ago in Europe in experiences such as the Inspire Directive, Directive 2007/2/EC (EUROPEAN COMMUNITY, 2007), which establishes the creation and full availability of a spatial data infrastructure, for example.

In short, the visualization, and more specifically the geovisualization, seems to be an interesting path for the implementation of the participation techniques. Considering the several levels of visualization presented by the case studies assessed by the present work, visualization was the base for the progress, understanding, sharing and dialogues in addition of enabling the experience of 'coming out of the box' by means of having contact with new and not foreseen ideas. It is then proved that the visualization facilitates the generation of the endorsement or not for the decisions made during the participatory meetings.

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