INTERACTIVE VISUALIZATION TOOL (INVITO): A WEB VISUAL TOOL FOR SHARING INFORMATION IN TERRITORIAL DECISION-MAKING PROCESSES

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Abstract

Territorial planning is the focus of considerable debates, which often develop into uncertain and vulnerable decision contexts.

Numbers and quantitative information in fact often dominate the process of decision-making but they are not easily comprehensible through quick and simple reasoning. Nonetheless, the huge quantities of data that describe our cities and regions could provide excellent bases to analyze spatial data in order to assess territories and simulate future development scenarios.

The application of innovative digital tools in the analysis of urban issues offers new advantages and opportunities for the improvement of communication values in policies and decision-making processes, concurring to overcome conventional approaches to territorial management.

The paper describes the application of the Interactive Visualization Tool (InViTo), a web tool based on maps and visual analysis allowing data to be filtered, explored, interconnected and compared on a visual interface.

Data visualization, intended as the way to see the unseen (McCormick et al., 1987), is here used as a new paradigm to highlight the positive and negative effects on spatial systems considering the impacts of choice-alternatives along multiple dimensions. The correlation between information and their localization generates an essential instrument for the knowledge of urban dynamics and resilience in answering to specific policies.

The investigation of a number of case studies shows the possibilities and opportunities given by the use of InViTo in creating a shared knowledge between actors involved in decision-making processes and in offering a challenge for integrating new perspectives on the analysis of future cities and regions.

1 Introduction

The on-going urbanization has lead to an increased focus on cities (UN, 2012) highlighting their inability to offer adequate facilities to their population. In fact, such complex congregation of people tend to become disordered places (Johnson, 2008) generating sets of material and non-material problems. The first set comprises among others difficulty in waste management, scarcity of resources, traffic congestions, aging infrastructures and energy management (Borja, 2007; Marceau, 2008; Toppeta, 2010; Washburn et al., 2010). The set of non-material problems are instead related to social and organisational matters associated "with multiple and diverse stakeholders, high levels of interdependence, competing objectives and values as well as social and political complexity" (Johnson, 2008; Weber and Khademian, 2008; Dawes et al., 2009; Chourabi et al., 2012).
In this sense, urban and social issues can be considered as "wicked problems" (Rittel & Webber, 1973)

creating potential conflicts and unanticipated effects. Due to the complexity of the cities, the mission of an urban project is never so clear including a wide number of data, variables, parameters, indexes and qualitative elements usually barely measurable.
Moreover, while in the past one of the difficulties in urban planning was the lack of data-measuring activities, nowadays the problem is the opposite: there is a huge amount of quantitative and qualitative data but they are often difficult to read. Therefore, databases need to be not simply able to visualise data but also to extract and process usable information (Belton and Pictet, 1997; Mingers and Rosenhead, 2004; Belton and Stewart, 2010; White, 2006; Montibeller et al., 2008; Pensa et al., 2014; Lami and Franco, 2016).

The application of Information and Communication Technology (ICT) is often mentioned as part of the solution to those complex problems and the term 'smart city' is increasingly being used in this context (Hilty et al., 2011; Lövehagen and Bondesson, 2013).

However, despite that ICT are definitely enhancing the opportunities for spatial planning changing the common vision of the social inclusion (Goodspeed, 2011; 2012; Resch, Summa, Sagl, Zeile, & Exner, 2014;) they often present huge difficulties in being applied in daily practice (te Brömmelstroet, 2010; Vonk, Geertman, & Schot, 2005): 1) it takes a long time to calculate results which hinder the interaction between data models and users; 2) data models generally have low flexibility to adjust to specific needs; 3) most of these support systems have limited abilities in communication.

Communication is in fact one of the main features to be considered when talking about effectiveness of ICT for smart cities but the approach of communication by simply "writing down your objectives and stating your priorities, is inadequate for decisions worthy of thought" (Keeney, 2013; Lami et al., 2014).

Thus, spatial planning is currently encountering new approaches to the use of technology. In particular, both the academic researchers and professionals are increasing their interest in data-driven methods (Kamenetz, 2013; Lanzerotti, Bradach, Sud, & Barmeier, 2013; Kokalitcheva, 2014) investigating new tools in order to allow information to be easily extracted from data and disclosed to the stakeholders involved in a urban planning process (Bawa-Cavia, 2010; Neuhaus, 2011; Chua, Marcheggiani, Serrvillo, & Vande Moere, 2014).

In this context, the paper investigates three case studies describing the application of the Interactive Visualization Tool (InViTo). InViTo is a web tool based on maps and visual analysis allowing data to be filtered, explored, interconnected and compared on a visual interface (Pensa et al., 2014). The aim of InViTo is to built a shared basis of discussion among the actors involved being interactive in order to allow adjustments during a urban processes. Furthermore, InViTo offers a way to represent different typologies of geo-referenced data and to combine them in order to visualise the "hidden connections" (Dodge, 2005) among these data.

After the introduction the paper is organized as follows: section 2 reports the methodology adopted focussing on the development of the InViTo tool; section 3 shows some examples of applications of InViTo; finally, the conclusions resume the potentialities of the methodology adopted and further developments.

2 Methodology

2.1 The InViTo tool

Developed in 2011 (Pensa and Masala, 2014) as a visual support for spatial planning and decision-making processes, InViTo is conceived as a toolbox for supporting the analysis, the exploration, the visualisation and communication of data in order to facilitate policy and decision-making, improving the communication between actors coming from different backgrounds.

In its current version, InViTo can be classified within the category of spatial Decision Support System (sDSS) (Malczewski, 1999) as a Web-GIS tool. In fact, it is a web platform conceived to present GIS data and let people to play with those in order to increase the level of knowledge on spatial issues among both expert and non-expert people. Nevertheless, new developments allow the exploration of non-spatial data too, so that interactive info-graphics can be visualised and analysed.

The building of a web platform structure was the first essential step to develop the instrument creating the general framework of the tool. Its building took several months and has been progressively adapted to the development of other elements composing the tool. In order to be really accessible, the tool was based on an open source structure and open source initiatives.

InViTo is composed by two main sections: the back-end and the front interface.

The **back-end** is destined for GIS technicians, planners and administrators of projects. Here the logged-in users can create new projects and manage existing ones deciding the information that need to be seen by final users. Moreover, in the back-end interface, the logged-in users can decide the filter modality choosing among checkbox, dropdown menu, range sliders or single choice range sliders. Finally, specific buttons provide possibilities for customising the visualisation or for enabling particular elements such as tables, analysis grids or background maps.

The **front interface** is destined for final users. In fact it can be public and allow people visualizing, filtering and exploring data related to specific projects. The front-end interface is graphically structured by two main elements: a viewer window containing an interactive map and a vertical menu on the left side containing all the parameters settled by the logged-in users in the back-end interface (Figure 1).

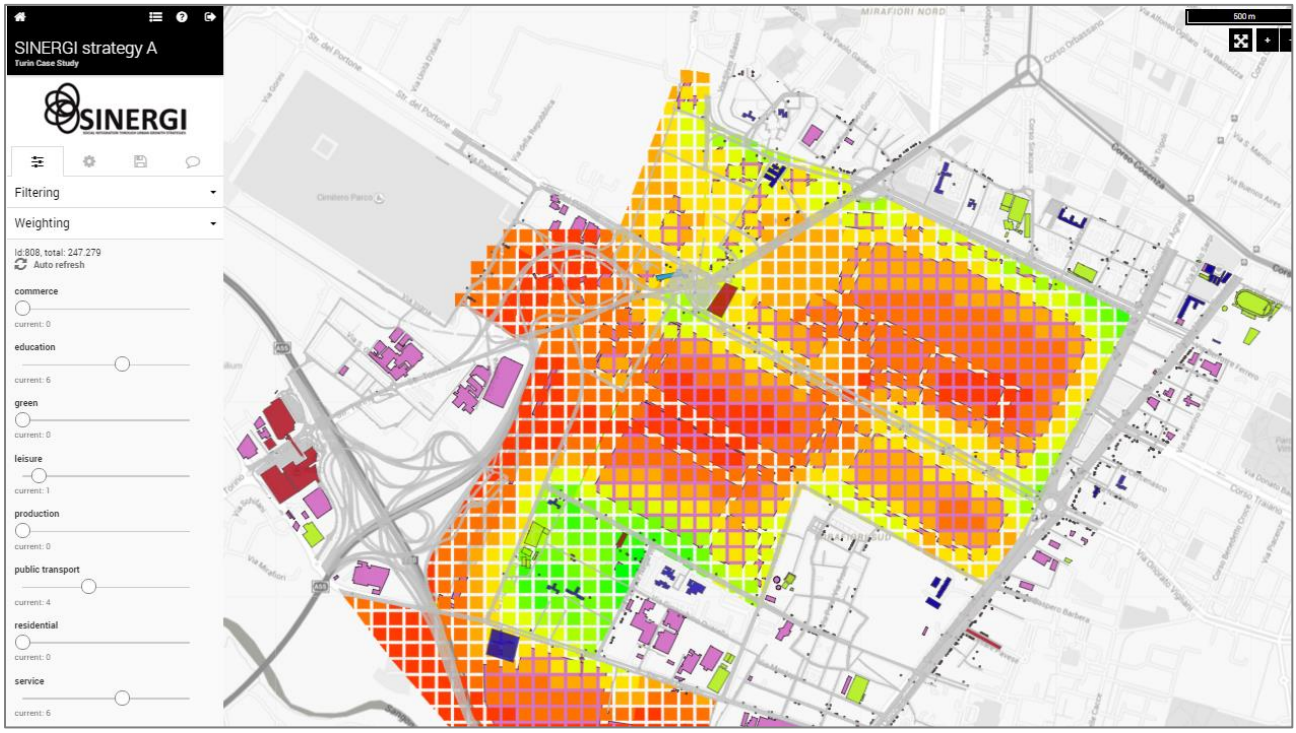

Figure 1 Front interface of InViTo: a window containing an interactive map on the main frame and a vertical menu on the left side.

The structure of the front interface can be in turn divided into three subsections: data filtering, map weighting and data visualization.

The **data filtering** section allows data to be interactively selected and filtered by the end users in order to customise the visualisation. Despite basically InViTo works as other GIS viewers, it does not visualise only the different layers of a set of data, but it allows users to explore the single records of a dataset by the use of different kind of pre settled filters. Moreover, the filters can be grouped in panels, so that the visualisation can be driven through a particular path to follow. Moreover, InViTo allows data to be investigated at different levels with also intersection of attributes, in order to analyse data clusters in relation to specific parameters. In this sense, InViTo overcome the data-map representation to arrive to the visualisation, intended as the discipline to see the unseen (McCormick, De Fanti, & Brown, 1987).

The **map weighting** section allows the filtered maps to be overlapped and weighted on the basis of their priority. The aim of the map weighting section is to provide users with a tool for analysing the localisation of expected effect of specific elements and evaluating the sum of effects on the basis of a specific mathematical curve associated to the layers. This section is an on-going part of the research. In fact, the map weighting is currently based on the sum of maps as in the basic methodology of Multicriteria Decision Analysis (MCDA – Figueira et al., 2005). Further developments of InViTo will improve this section in order to integrate the opportunity to develop MCDA directly in the tool as the spatial Multicriteria Analyses combining GIS and MCDA (Malczewski, 1999; Ferretti, 2013).

The **data visualization** settings allows a high level of customization on colours, dimensions, styles, map styles (between Open Street Maps or different Google Maps styles) and on a series of utilities by means of which the tool is expected to offer a wide range of possibilities for users to improve their analytical skills and enhancing the discussion. Furthermore, users can visualize tables and charts showing data according to the filters activated in the filtering section. The tables show the attributes related to the filtered data, providing pre settled additional information field by field. The charts show the values of the filtered data in relation to the whole set of data, highlighting the selected geometries.

The distinctive features of InViTo are therefore dynamicity and interactivity, which make it open to variously skilled users and suitable to be part of instrumental equipment for meetings and workshops. In fact, it can be used by a single person or collectively during discussion sessions. In this case the displayed map can become the interface for sharing opinions and reasoning. In fact, its quick responses and visual interface offers possibilities for improving the discussion among people, providing a shared basis for enhancing the debate.

3 Case studies

Spatial decisions and policymaking processes affect, or can affect, the geography of an area at different spatial scales. This can happen with a very wide spectrum of consequences, which can be studied by different discipline fields such as urban planning, transport planning, mobility, environment, social and economic sciences. The InViTo structure was conceived as open as possible in order to avoid constraints in the use of the tool. Thus, it can be used for dealing with different case studies, with different purposes and afferent to various disciplines. The following three case studies show some example of applications of InViTo.

3.1 SINERGI project

The Social Inclusion through Urban Growth Strategies (SINERGI) is a project funded by the “Europe for Citizens” programme. It involved four cities as Skopje, Lisbon, Turin and Zagreb, in a number of seminars and workshops oriented to the improvement of the process of social inclusion within the urban planning.

In order to achieve the project objective, InViTo has been chosen to perform the SINERGI workshops. The first workshop was held in Skopje in December 2014 and was focused on the evaluation of three infrastructural scenarios for an urban area in the same city. The second workshop was held in Turin in June 2015 and concerned the renewal of a huge dismissed urban area with an industrial past and many future projects insisting on it (Figure 2).

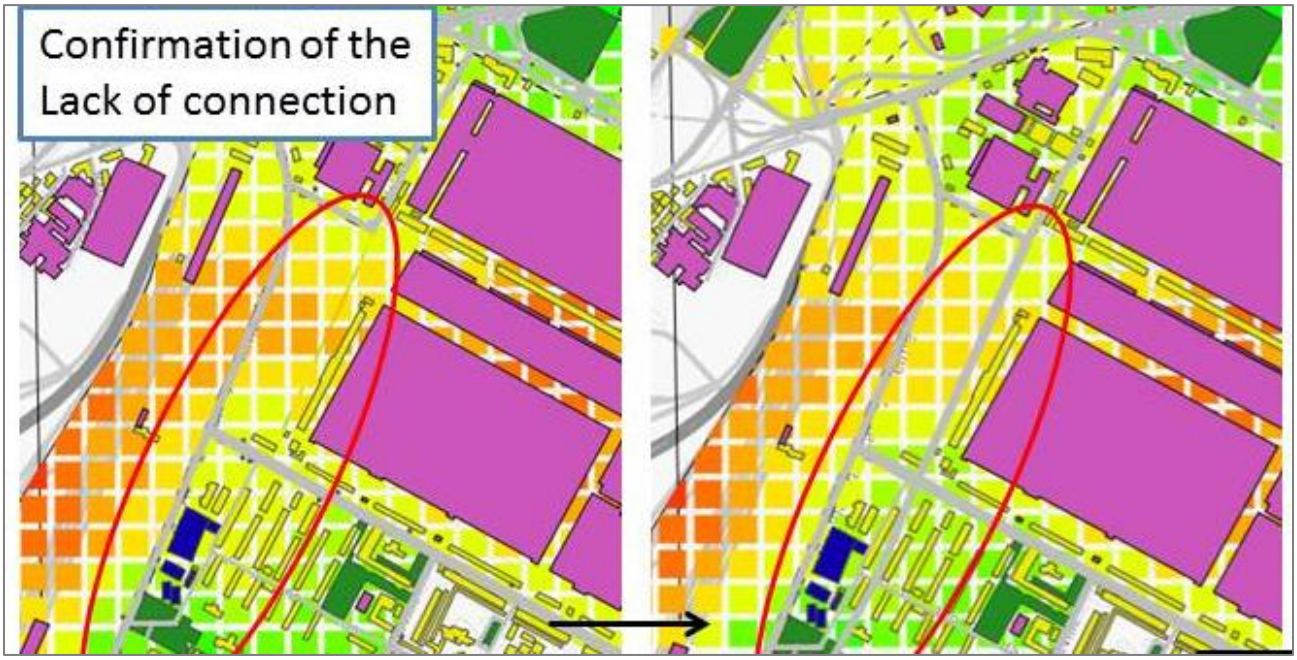

Figure 2 The use of InViTo during the second SINERGI workshop, Turin, June 2015: identification of an existing infrastructural lack (left) and checking of a design idea for a new road (right).

Both the workshops had a diversified public, composed by city administrators, technicians, academics, students and social representatives. A number of discussions emerged outlining possibilities and opportunities given by the use of interactive maps designed to facilitate and improve the interaction between the information and the actors involved in the planning process.

The tool has been used to detect critical areas and areas with more opportunities. After the discussion of some design alternative options, InViTo has been applied to evaluate “what if” scenarios. The outcome provided by the tool gave no solutions, but opportunities for the participants involved in the workshops to discuss and elaborate a shared solution.

3.2 CODE24 project

During an Interreg IVB NWE Project named “CoDe24” (INTERREG IVB NWE, 2005; ERDF European Territorial Cooperation 2007-2013, 2010), the Interactive Visualisation Tool has been used for several events and purposes. One of these concerned the exploration of the total number of trains arriving and departing from the Frankfurt am Main railway station between 8.00 a.m. and 9.00 p.m. of a common working day (Figure 3).

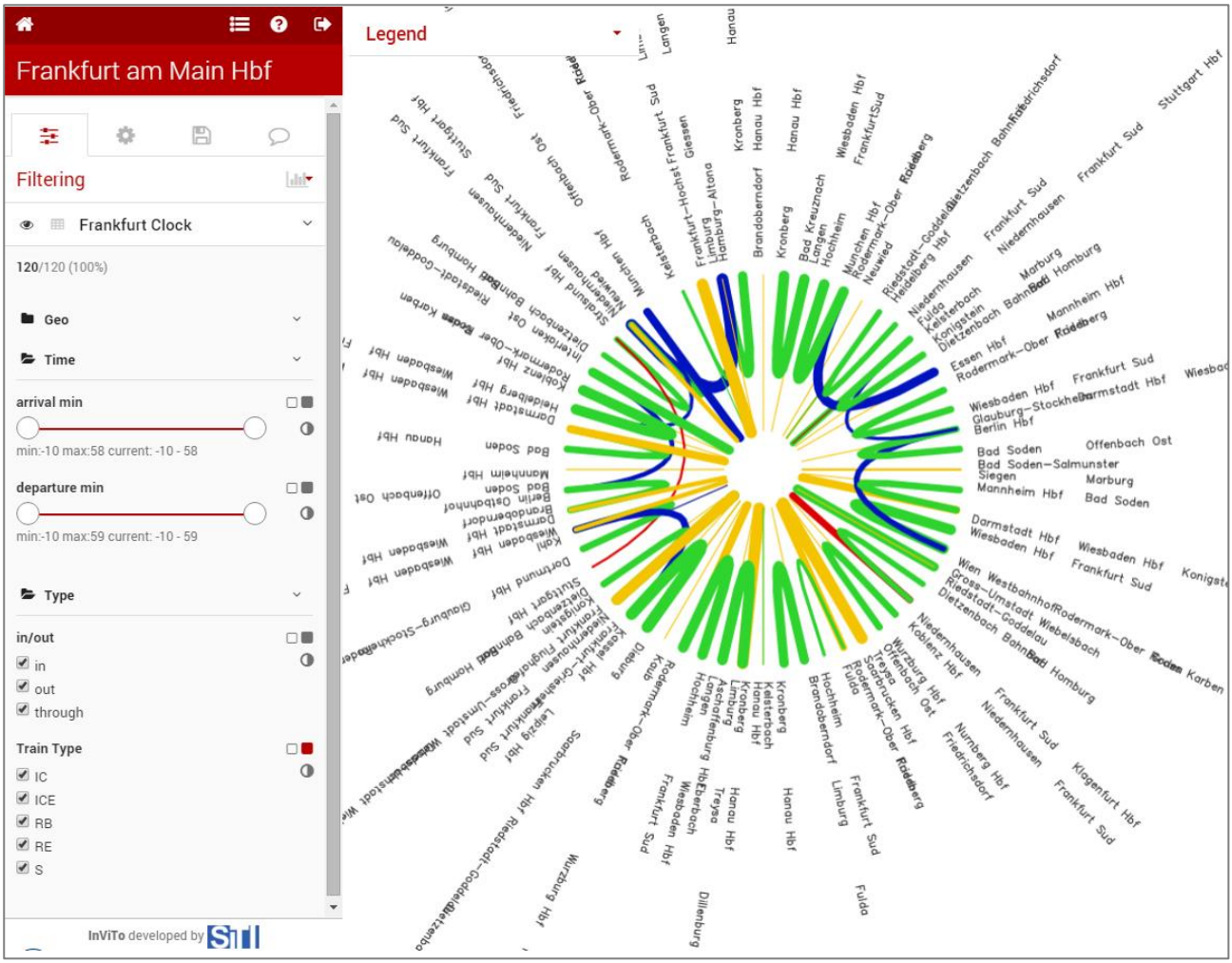

Figure 3 The use of InViTo for visualising the railway connections of Frankfurt am Main between 8.00 a.m. and 9.00 p.m.

The visualisation of data is interactive. Users can choose the setting and filtering of a number of parameters, such as the train typologies, the city of origin or the city of destination.

Unlike other projects, in this case the represented data are not spatial. They are organized within an info-graphic without background maps or geographical references. The geographic information is restricted in the selection of filters.

The online use of this application provided the possibility to share the information between the partners of the project. Furthermore, it generated an intuitive visualisation of the railway connections of an important city like Frankfurt am Main, the train arriving, outgoing or passing by the city, the typology of the trains and the possible integrations among the different trains. Colours and thickness of lines change according to the setting made by the users, providing further information on the selected elements.

3.3 Tweets in Barcelona

A third case study concerns the visualization of tweets sent from the metropolitan area of Barcelona in the period January 7-19, 2015. The research is part of the TUD COST Action TU1306 - Fostering knowledge about the relationship between Information and Communication Technologies and Public Spaces supported by strategies to improve their use and attractiveness (CYBERPARKS). The objective of the research was the improving of the design of public open spaces by means of information captured by the analysis of user-generated data.

The data collected from Twitter have been elaborated and uploaded in InViTo. The visualisation allows users to interact with a large amount of data (more than 67.000 records) and to understand the urban patterns generated by Twitter's users by the self-exploration.

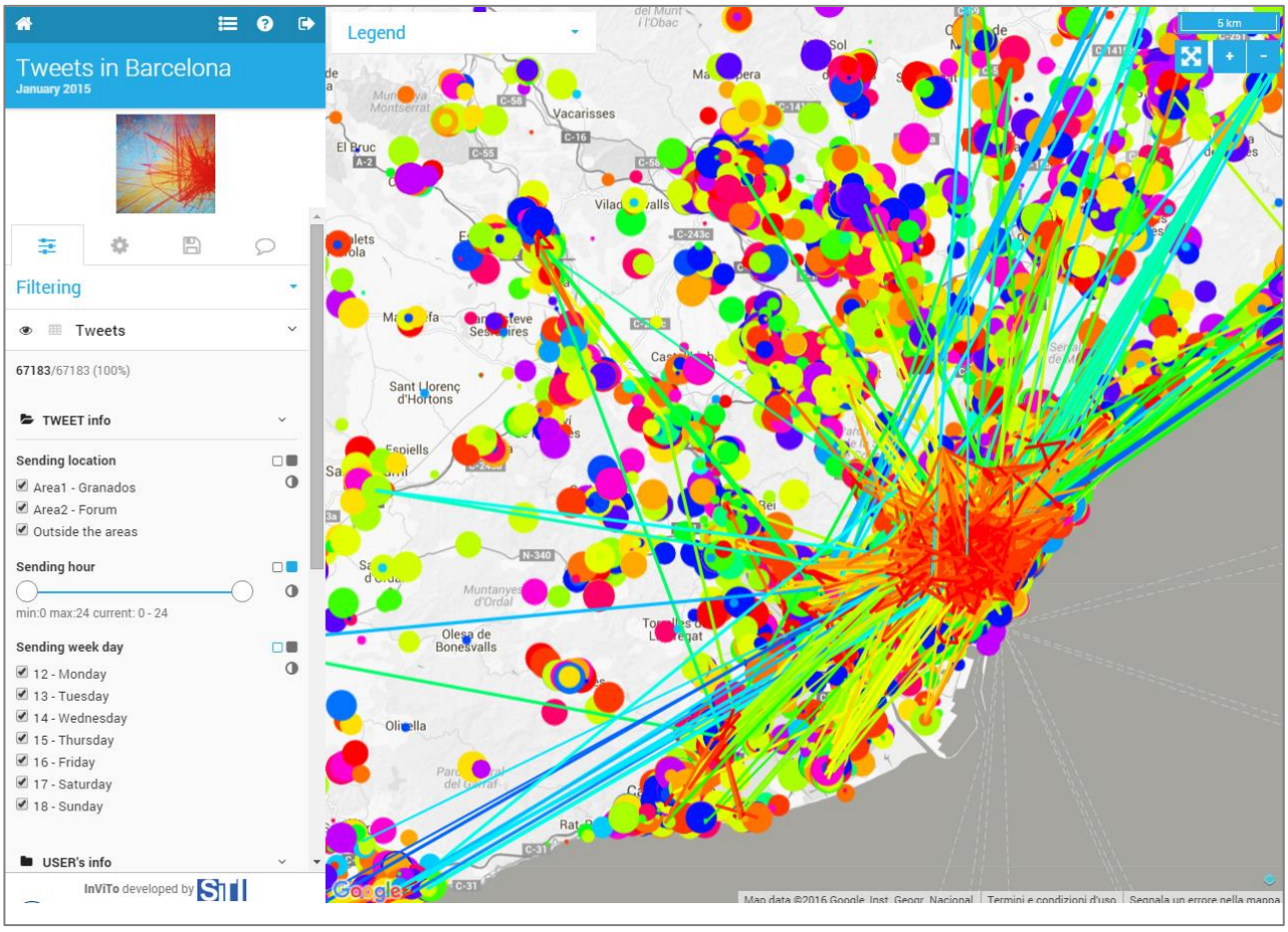

Figure 4 The visualisation of Twitter Data in Barcelona, collected in January 2015.

The large amount of maps that can be obtained by such a data exploration is sufficient to identify several urban patterns and understand some dynamics on the use of the city. In particular, the tool showed to be very important for analysing the tweets following both a spatial and a temporal logic. The differences in tweets spatial distribution according to the temporal period selected provided new insights on the analysis of the city. These outcomes highlighted a number of issues related to the tourism and the use of the city in relation to the origin country of people visiting Barcelona.

4 Conclusions

The three case studies are a small example of possibilities in applying the tool. The high level of customisation of the filtering and weighting sections as well as of the visualisation provide a large amount of opportunities for the information sharing between large groups of people. The use of visualisation goes against a technocratic vision of cities and increases the power of experts. It allows planners, city administrators, technicians, but also common citizens, to improve their awareness of urban problems. A higher knowledge enhances the decision-making process, providing opportunities for better choices.

Furthermore, a high flexibility of the tool allows the instrument to be adapted to the case study and not, as often, the planning adapted to the possibilities given by the tool. By this way, the urban tool is not a constraint but a real support to the urban planning.

Future developments of InViTo will foreseen the improvement of the MCDA section currently drafted in the tool in order to better weight the maps provided and enhance the usability of InViTo in supporting urban planning.

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