Production of spatial representations through collaborative mapping. An experiment.

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1. Introduction

Territorial planning has been interested in the representation of space since the seventies (Dennis, 1970), when it recognized as essential the support of the social actors in decision-making. The participatory construction of spatial representations evolved ever since: Starting from the paper representation, which is very expressive but has low usability and lacks scalability, it moved to the use of GIS systems (Steiniger and Hunter, 2013) and of digital instruments for managing geographic data and generating dynamic maps. The idea was that of allowing the user to view information "on demand"; however, digital maps have lower capacity to describe the perception of the area because they focus on the visualization of specific types of data and they are semantically disconnected.

An interesting research topic for planning theories is therefore that of investigating the possibilities offered by Web 3.0 and integrating them with traditional representations for improving the effectiveness of public policies and supporting the construction and upgrading of planning instruments. Notice that Amin and Thrift (2001) discussed the idea that the traditional means of investigation and spatial analysis are insufficient to represent the new complexity of the urban issue and, more specifically, unable to relate phenomena and emerging urban forms that characterize the territory.

This paper focuses on the theme of the spatial representation of cities and the territory, reflecting on the prospects for innovation in the expressive means that serve the study of the city. The described research concerns project “Mappe di Comunità 3.0” (http://ontomap.dyndns.org/), funded by the Fondazione CRT. The project focuses on the definition of a methodology that implements a synergistic exchange between institutional territorial knowledge and the knowledge of the citizens, achievable thanks to the mediation of communication provided by a semantic representation of territorial knowledge. That type of representation supports the description of data and of its properties in a unified language. Moreover, it enables the sharing of information on the Web by providing an integrated perspective on territorial data.

2. Methodology

Harper (1988) defines visual sociology as the recording, analysis and communication of social life through photographs, movies and videos. There are four fundamental aspects of visual sociology in this interpretation: (i) analytical purpose and type of knowledge that the researcher seeks to bring to light; (ii) importance of the recording medium; (iii) exploitation of pictures for representing a culture; (iv) analysis of the images produced by a culture to understand it.

Our work applies the methodological perspective of visual sociology to the collective production of virtual maps through a web-based tool. The images consist of geographic, visual and semantic maps, close to the community maps because of two characteristics: the purpose-identification of local heritage, and the method-self-representation. Through a traditional community map the inhabitants of a place have the opportunity to represent heritage, landscape and knowledge in which they recognize themselves and that they wish to pass on to the new generations. The map highlights the way in which the local community sees, perceives and attaches a value to its territory, to memories and transformations, and specifies how it should be in the future.

Traditionally, community maps consist of cartographic representations developed by the community, based on a participatory approach (Parker, 2006). The project Mappe di Comunità 3.0, closer to the PGIS practices, investigates the possibility of a new representation mode of those maps, using digital media and the semantic representation of spatial knowledge to promote a new account of the territory aimed at producing planning scenarios useful for Public Administrations (PAs). The main result of the project is the OnToMap web-based application, which supports the consultation of spatial data, the creation of virtual, interactive maps reflecting individual information needs, and the reporting to the public administration (PA) and urban planners of critical issues or new proposals by annotating the geographical areas and the elements visualized in the maps.

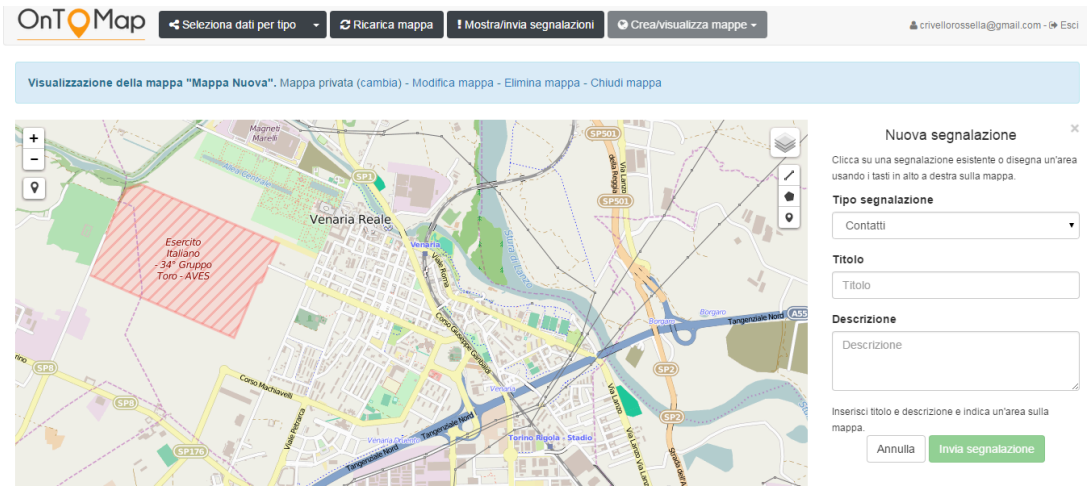

Figure 1. Portion of OnToMap's user interface: creation of a customized map and introduction of annotations about map elements.

Figure 1 shows a portion of the OnToMap user interface (in Italian) and the right side of the page shows the form for adding annotations ("Nuova segnalazione") to the current map.

OnToMap uses an ontology of the territory as the main metaphor for the human-computer interaction in information search, visualization and sharing. Ontologies, defined by Gruber (1995) as "an explicit specification of a conceptualization", describe objects and relations in an application domain. GIS typically use ontologies for supporting the integration of heterogeneous information sources (e.g., see Fonseca et al., 2002; Buccella et al., 2011). Differently, OnToMap exploits an ontology to mediate the specification of information items with the different perspectives on data held by users:

- Regarding the representation, the ontology supports the integration of heterogeneous geo-data, originated from different sources, and manages them as linked data[1], i.e. data items connected to each other through hypertext links in the Web. Moreover, it describes relations among information items to express spatial and thematic associations, as well as different levels of abstraction in their description (from general concepts to specific ones).
- From the viewpoint of information retrieval, the ontology provides the user with a graphical tool for browsing the information space as a graph of connected concepts. This supports semantic information retrieval and visualization in the maps.
- Finally, from the crowdsourcing viewpoint, the ontology supports the description and classification of new information items, which can be included in the existing knowledge base for immediate usage.

Figure 2 shows a portion of the ontology underlying the OnToMap system. The representation directs the interpretation of the territory, which is read in the project according to three constitutive dimensions: natural (*Natural perspective*), artificial (*Artificial perspective*) and normative one (*Norms*). The natural dimension refers to the physical elements unaltered by humans; the artificial one includes the man-made elements; the normative dimension considers the technical and design aspects related to the sphere of competence of PAs, explaining in space the territorial government regulations, expressed as institutional and planning constraints. These three observation levels take into account issues related to different domains of representation of material aspects, represented with GIS techniques, socio-economic aspects, highlighted by semantic relationships, and perceptual aspects, typical of the voluntary construction of knowledge. Therefore, the ontology is the means used to provide a unified description of the territory, which abstracts from specific data representation formats and supports data integration. However, it also plays the role of an "inter-lingua" between human stakeholders, who might be interested in the analysis of content under different points of view and in retrieving information at different levels of detail: e.g., a geographical item could represent at the same time a service for the citizen, a cultural heritage element, etc.

[1] As reported in http://linkeddata.org/, "Linked Data is about using the Web to connect related data that wasn't previously linked, or using the Web to lower the barriers to linking data currently linked using other methods."

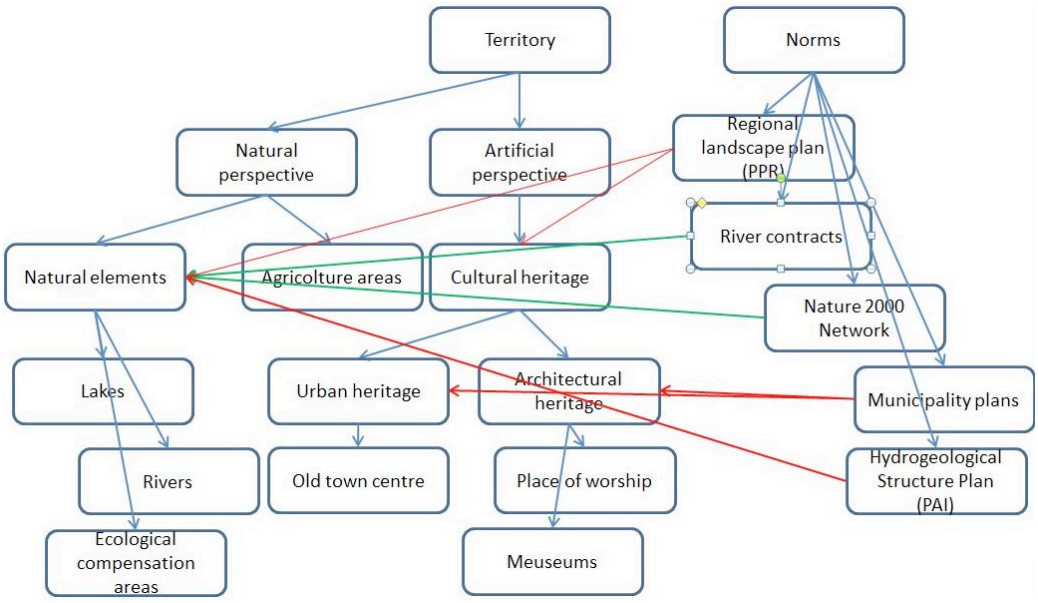

Figure 2. Portion of the OnToMap ontology. Blue arrows represent specialization relations (from generic to specific concepts); red arrows denote normative relations and green ones represent topic relations among concepts.

3. Results and Discussion

We tested the OnToMap application in the Urban Project Atelier at the Faculty of Architecture of the Polytechnic of Turin, in the academic year 2014/2015. Students (51 divided into 15 groups) of the course used the application in classrooms equipped with computers and Internet access under the supervision of the research team that accompanied the creation of the maps. The students used OnToMap to experiment with new modalities of representation for describing the territory of the project, from an analytical to a projectual point of view. The students created 15 Analyses and 15 Project Maps: the interpretation of these products was verified according to four reading criteria:

1. mode of use of the tool to read the territory,
2. semantic elements useful for the construction of the territorial representation,
3. semantic elements used for representing the concept of territorial identity,
4. representation mode of possible projectual scenarios.

The representations generated by the students using the OnToMap application are articulated on two distinct levels: a spatial one, linked to the direct drawing on the virtual map, and semantic one, connected to the use of the concepts defined in the ontology. It is useful for the purposes of the research to understand how the two representations relate to each other, producing visions that are similar, different or integrated. The maps become the starting point for the construction of an index of perception of a social group (here, the group of students of the urban design Atelier).

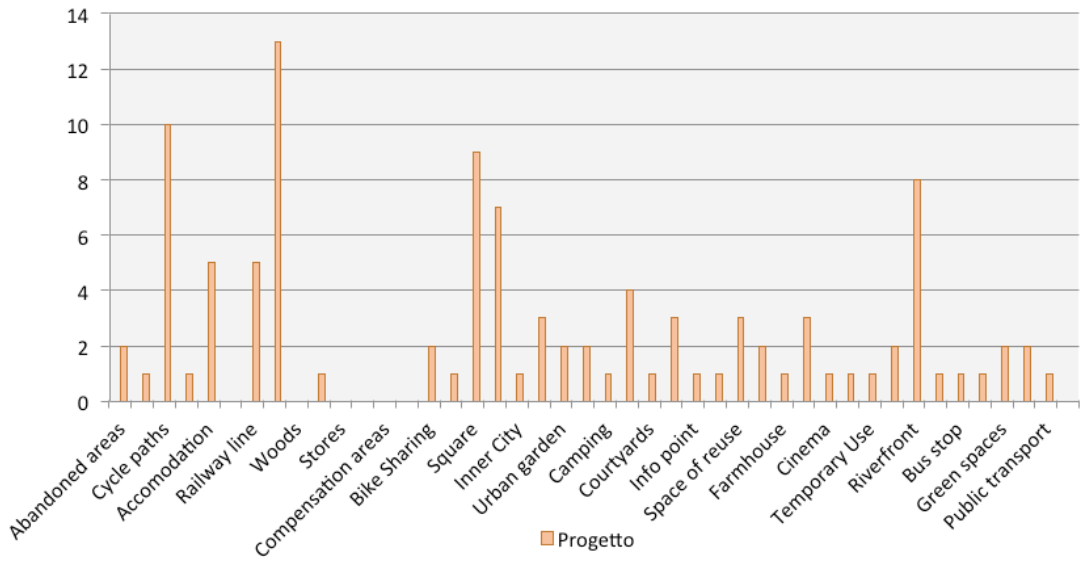

Figure 3. Analysis of the concepts belonging to the ontology that were used for the Project Maps.

The experimentation has indeed proved that some territorial elements, selected, viewed and edited through OnToMap by students, are recurrent in most of the created maps (Figure 3). We can therefore deduce that the highlighted territorial elements reveal the expectations and vision of a given social group, with a proper and specific cultural background.

4. Conclusions

OnToMap was used with the objective of stimulating territorial interpretations, bringing to light new and innovative points of view of the territorial reality in an analytical and projectual perspective. The ontology underlying the system supports an articulated spatial representation, enhancing spatial planning with a more comprehensive territorial reading. However, the experimentation identified missing concepts that users could not directly add because this task requires technical expertise. This limitation, intrinsic of knowledge-based systems, must be addressed by supporting a participatory approach to the specification of semantic knowledge. A specific work can be directed precisely at the construction of a shared and participated spatial ontology, with the purpose of representing not only the territory, but also the community that perceives it, *empowering* the community to express their own views. If, as assumed by visual sociology, visualization is a practice of power (Faccioli, 2010) that allows the definition of social and cultural differences by explaining them visually, working on visualization means deconstructing the different layers of meaning of images produced. This operation strongly refers to the construction of a conceptual model of knowledge that is also visual, such as that of ontologies. The OnToMap project fits well into this perspective, combining visual, spatial and cartographic representation with conceptual and semantic representation.

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