Web 3.0 and Knowledge Management: Opportunities for Spatial Planning and Decision Making

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Abstract. The overabundance of information produced by new technologies, if on one side can be considered as a knowledge enrichment in planning process, on the other side it has not improved neither reality understanding nor possibilities of intervention. Old forms of citizens participation to planning process, generally based on assemblies, have been replaced by continuous discussions on social networks, blogs, etc..

The attempt to take into account the huge data flow produced everyday, it is not an easy task for planners. An ontologies based approach can represent an important support to such activities.

"Comelicopedia" an European project between Italy and Austria, probably is one of the first experiences in applying ontologies to spatial planning process.

All potentialities in planning and decision making fields will be analyzed and tools, such as "comelicopedia", can become usual in supporting a regulatory dialogue between decision makers and citizens.

Keywords: Spatial planning, Decision making, Knowledge management, Ontology, Citizens participation.

1 New Technologies and Information Overload: Problems and Opportunities

The problem of overabundance of information sources, not always seen as a cultural enrichment, has always been discussed, even in ancient times, when spread of knowledge was totally restricted to specific social categories. Seneca [1] in ancient Rome, affirmed that the abundance of books is a distraction. Too many books are dispersive: since you cannot read all the volumes you may have, you should just own the right number that you can read. It is better to prefer authors with recognized value and if occasionally you can think to switch to other authors, then return to the first ones. Reading a huge number of different authors and all kinds of books is a sign of inconstancy and volubility: if you would like to have durable advantages it is important to insist only on certain writers.

The term "Information overload" introduced in social science by Myron Gross [2] is related to information overabundance which generates barriers in an effective

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understanding of reality, limiting the information process and producing a cognitive inability. Toffler [3] introduces also the term over-choice when diversity advantages are dissolved by decision-making process complexity.

In recent times, there has been a transition from traditional web pages to a new emerging Internet model, the web 2.0, based on extensive content generation by users and on collaboration. In addition, there is also an impressive increase of geographical information production, due to the growth of spatial data infrastructures, such as Google, which transformed geographical information from a specialist interest to a mass phenomenon and the great GPS diffusion in mobile devices, so that every person owns at least one GPS [4] [5].

Today we are in the information society, based on information opportunities, where the object is not simply knowledge but the possibility of accessing it producing and diffusing new knowledge. This means that different informal or tacit knowledge can emerge, finding an expression channel, but also incomplete, erroneous and tendentious information which can be diffused.

We live in a world with an overabundance of information, which produces a lack of everything that information consumes, mainly the attention of people who receive the information itself. Therefore, wealth of information creates a poverty of attention and a need to efficiently allocate that attention within the overabundance of information [6].

There are not solutions, but dilemmas. Among the various information dilemmas, two metaphors can be suitable in describing overabundance of information. The puzzle metaphor: knowledge is fragmented and everyone should build it time to time and as needed. The filter metaphor: if mesh is too narrow, we know what we are looking for but we lose time to discard; if mesh is too large, everything passes and we find big misunderstandings, failures and information should be filtered again.

Collective intelligence occurs wherever there is a huge human interaction and new technologies can easily encourage synergies even among geographically distant people. Someone who lives in a remote part of the world can interact with other people with complementary knowledge, living very distant, continuously communicating with each other, exchanging their experiences, cooperating, etc. [7]. Collective intelligence can be defined as an information mixed with different points of view producing synergies and developing complementary aspects.

2 New Technologies in Citizens Participation to Planning Processes

These forms of collective intelligence can be particularly useful in citizens participation to planning processes, enriching the construction of cognitive frameworks, improving knowledge management and supporting decision making.

In first experiences, the support of participatory planning processes served mostly the purpose of consensus building, within the combined action of technicians and politicians. A triangulation of knowledge (technical, political and local) has been built in a circular relationship, constantly looking for spaces of mediation, negotiation and sharing as well as the co-construction of a chain choices-responsibilities actions [8].

The groupware concept [9] represents one of the first attempts to adopt technologies in participatory planning processes, building actors network, increasing production and quality of information, improving interoperability and data access. This concept allows to identify a family of techniques to support multi-actor cooperation, leading to conflicts resolution and agreements between parties in building future projects. Groupware success consists of an equation which considers all of the following elements: technology, culture, economics and politics [10].

The term "participatory GIS" has been coined to highlight a trend towards democratization of techniques. Subsequently, this definition evolved considering other aspects, such as critical evaluation of uses of GIS in society [11], to foster a grassroots involvement in policy decision-making [12] and an analytic-deliberative approach to policy decision-making for situations with high decision equity [13].

Very important was the introduction of argumentation mapping tools [14], also.

The advent of web 2.0 increased a transition from a one-way approach, where citizens are only informed, to a two-way approach where citizens can express their opinion in a wiki-way [15]. Blogs and social networks are collectors of citizens instances, leading to virtual deliberative arenas [16] and to wiki-planning [17].

The same diffusion of deliberative acting in several cases challenged the role of representative democracy, creating more space for participatory democracy and its tools. Also, occasional participatory events are information and education moments, producing different nature of knowledge in participants, who become wide diffusion elements of social change. This change is added to the traditional innovation due to local associations activism and political actions.

A lot of new terms have been coined to define various aspects of collaborative actions. Volunteered Geographic Information [18] identifies a mass collaboration to create, manage and disseminate spatial data; Crowdsourcing means the possibility of obtaining suggestions, services, ideas, support in decisions by actions of online communities [19]; Neogeography [20] describes a bottom-up approach to geography integrating maps with geo-tagged photos, videos, blogs, Wikipedia, etc..

In Iceland, for instance, after banks collapse, the government allows citizens to discuss and propose their ideas through crowdsourcing. UK Prime Minister David Cameron adopts a sort of dashboard, which synthesizes main data concerning the Country, polls and Twitter feed. New York Major Michael Bloomberg defined Twitter as a source of everyday referendum. If social networks collaborative approach can increase a “planning through debate” [21], it is also important to consider the “rational ignorance” [22]. Citizens often trivialize the concepts or manifest inertia in understanding technical issues. The main barrier in knowledge increase using technologies is due to semantic discrepancies. In planning participation process this barrier is more evident in the transition from the technical sphere to more shared levels, such as political and common (social) knowledge.

It is very common that a well defined concept in the technical sphere does not match with a concept with the same name in political and social sphere. Often all actors involved in a planning process do not adopt the same language in describing the same concept [23] [24]. The most adopted approach to overcome semantic barriers is represented by ontologies.

3 Ontologies and Spatial Planning

The term Ontology originates from philosophical disciplines, reaching a large spread in the field of artificial intelligence. A definition, shared by philosophers and computer scientists, considers ontology as "the theory of objects and their relationships" [25]. In this section the attention will be focused on the evolution of informative bases of the ontological nature for planning purposes. Great interest will be paid to test technical tools for knowledge management and decisions support related to urban and regional planning aspects.

After the first phase, during which ontologies were relegated in the field of philosophy and artificial intelligence, the attempt was to put into practice what previously theorized, trying a first modeling and a geographical declination.

Mark and Smith [26] define ontologies related to the places different from all other ontologies related to objects of everyday life. Furthermore, they criticize the typical approach in developing an ontology, too close to expert issues, also highlighting that folks categorizations are important because they are transparent. Their ontology is the first case of an implementation shared to non-experts.

Hopkins et al. [27] mainly focus his research on the semantic of processes. His aim is to establish and define terms and areas of action to build, on these, a relational system, as much as possible discursive and narrative. The ontology has been developed to represent urban development processes, and elaborated for land use regulations. Plans are intentional actions directed towards change, and explicitly recognize relationships-agenda, design, policy and strategy among actions. This model is built on processes, strategies and time, in a few words on complexity, perhaps so much to make it an exhaustive and sophisticated model, but difficult to implement.

Laurini et al. [28] adopt a completely different approach, considering relations between elements and their transformation for interoperability improvement and a ready to use tool in Geographic Information Systems. In urban domain, two main objectives have been pursued: interoperability of urban information systems and clarification of main urban concepts. Ontologies, with the aim of ensuring systems interoperability, allow concepts clarification and deepening, often considered known with a certain superficiality [29] [30].

In seeking semantic interoperability, it is necessary to reach an agreement among all actors, choosing a definition which is a sort of compromise. This is the case of post consensus ontologies adopted in most cases. Once reached the agreements, the definition can be translated into Ontology Web Language (OWL). The problem is how to reach this consensus. In the case of well-standardized domains, as in the field of mathematics, chemistry, physics, etc., an agreement is fairly simple [31].

In a context with abundant definitions, with a very articulate vocabulary, achieving consensus is not an easy task. The domain analyzing territorial phenomena falls in the latter case, especially if one examines the context in different nations. Therefore, in this domain achieving consensus before ontology construction is not a trivial thing at all. For this reason Preconsensus Ontologies have been preferred, previously collecting all existing definitions, and then seeking consensus among all actors [32].

Another interesting ontology application in planning domain is a Land Use Planning Ontology [33] where Land Based Classification Standards (LBCS) developed by the

American Planning Association have been transferred in OWL2 producing a land use ontology adopted as a basic structure for the City Information Model. Other interesting experiences have been developed in Strategic Environmental Assessment procedure applied to city Masterplans in Sardinia Region [34], in Regional Development Programs [35] and in disaster and emergency management [36].

4 The Case Study: Comelicopedia

Today we have a lot of examples of ontology applications. The domain investigated in the case study is quite complex, the use of ontology in supporting decision-making process. In particular, Comelicopedia experience was developed within the European Project Susplan "Sustainable planning in mountain areas" (Interreg IV Italy - Austria 2007-13).

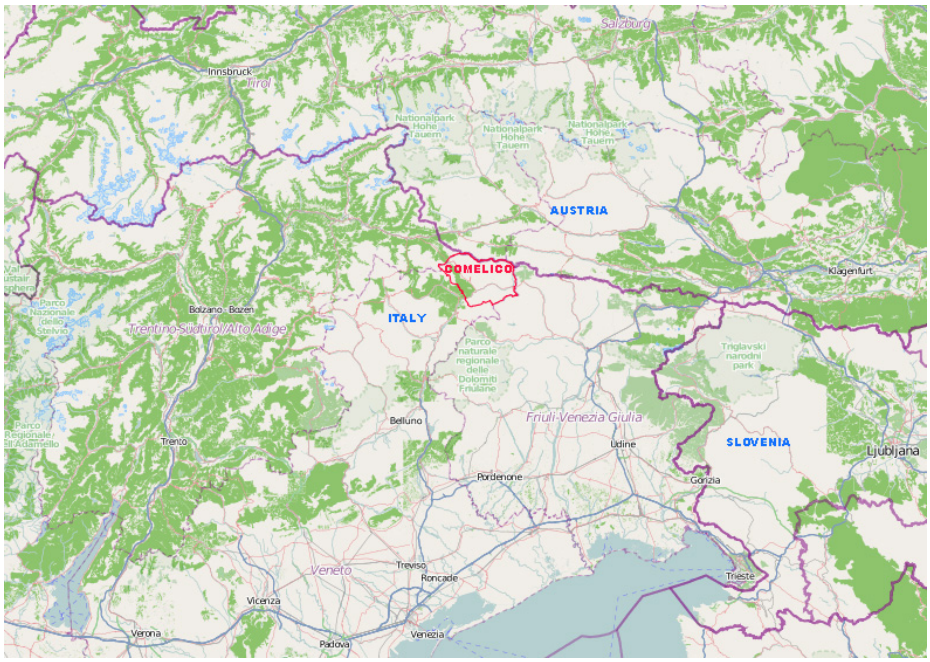

Fig. 1. Study area location (Source OpenStreetMap)

The term Comelicopedia comes from the term Comelico, pilot area of Susplan project. Comelico, also known as Comelico Valley, is an Italian mountainous region in Belluno Province close to the Austrian border. Comelico, from the administrative point of view, is also a consortium of communes in mountain areas with a population of 8908 inhabitants and it covers an area of 280 km², including five municipalities with Ladino language (Comelico Superiore, Danta di Cadore, San Nicolò di Comelico, San Pietro di Cadore, Santo Stefano di Cadore) and one municipality with German language (Sappada).

Comelicopedia experience is mainly based on three needs: developing an analysis of sustainable development concept evolution; attempting to reinforce, compare, and go beyond the assessment of policies, programs, plans and projects of territorial development (paying particular attention to Strategic Environmental Assessment); organizing a more effective and efficient knowledge base of political agendas to support decision-making and to build new common cross-border spatial development strategies.

These three main needs have been satisfied through two transversal and interrelated approaches: new information technologies (wikis, semantic web, ontologies, folksonomies, etc.) and participation.

In addition, a common spatial information system, among all partners, has been implemented, according to INSPIRE Directive and adopting Open Geospatial Consortium (OGC) standard ISO 1915.

This experience has been applied in a mountain area with great ecological and environmental values, characterized by marginalization and depopulation, as well as cross-border (inter-regional and international fundamental Interreg IV program requirements) territorial and ecological uniformity.

The peculiarity of the Italy-Austria cooperation project is the characteristic of three regions: Veneto ordinary statute, Friuli Venezia Giulia extraordinary statute and Carinzia foreign region. This area well represents all the major issues of mountain and its related planning problems [37]:

a) high degree of approximation in defining a conceptual framework that usually inspires political actions [38] [39];

b) elevated limits, both in expertise and in knowledge and in instruments that influence public decision-makers and other actors involved in the processes [40] [41];

c) poor ability demonstrated so far by both experts and citizens in delivering suggestions or information available (objectives, ideas, projects) to the decision level, where they can be conveniently collected and taken into account [42] [43];

d) perception of dissatisfaction, distrust and separation from the plans, programs and public policies.

For these reasons, Comelicopedia group worked to define methods and tools for "knowledge management", which was both opportunity and instrument both for knowledge dissemination and building learning community [44] [45], necessary conditions to achieve the objectives of sustainable local development.

Comelicopedia working group developed the ontological scheme [46] considering other experiences [27].

In parallel to the simplification and the operative translation of this ontological scheme, knowledge domain has been defined, more particularly types and forms of knowledge to be introduced in the system and reference sources.

Starting from the principle that all sources are equal in dimensions and importance three types-forms of sources have been considered.

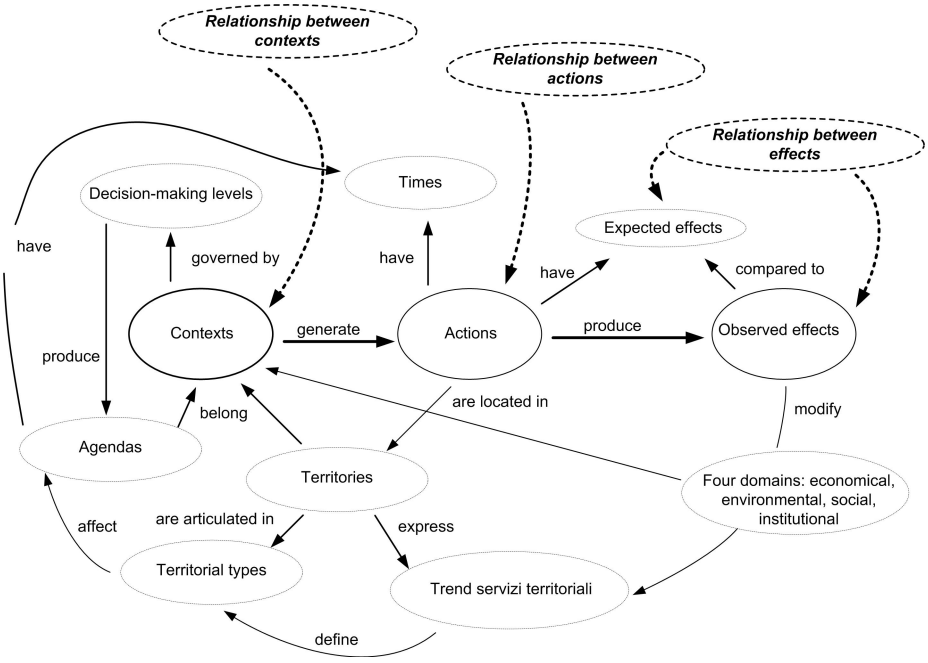

Fig. 2. "Comelicopedia" Ontological scheme [46]

First of all, formal written official sources have been considered, main political agendas defined by means of programming and planning documents, related to the study area, at different territorial level (regional, provincial, consortium of communes in mountain areas), accompanied by documents and national and international strategies concerning sustainable development. In order to build the ontological model, sources, producing top down knowledge, have been more useful. In order to balance knowledge from a non-institutional perspective, collecting local knowledge, many interviews have been realized adopting a semi-structured interview protocol [47]. This step is important to stimulate a debate and building a future local voice in order to produce a bottom-up knowledge. These two types of knowledge have been integrated with technical written sources, academic reports, specialist and informative, and practical source of knowledge based on experiences, examples of recognized and certified best practices tested in pilot areas (Fig. 2).

The objective of the introduction of these two new sources was to balance the information, taking into account knowledge and experiences of scientific communities and good practices to promote social learning and stimulating participation.

Participation could also provide assessment and checking of official sources, analyzing the correspondence between real needs and various analyses of the context and strategies put in place.

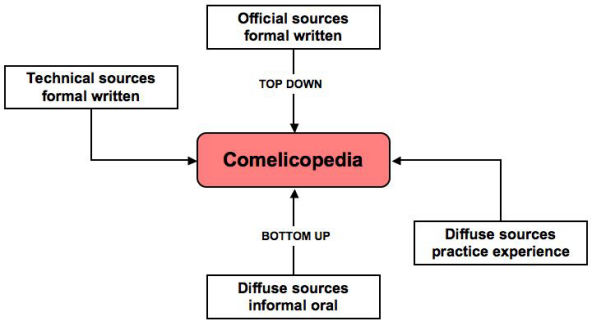

Fig. 3. Types and forms of knowledge adopted in Comelicopedia experience

The built ontology (Figure 3) is based on a knowledge tree structure, by means of Category tree and Semantic Network.

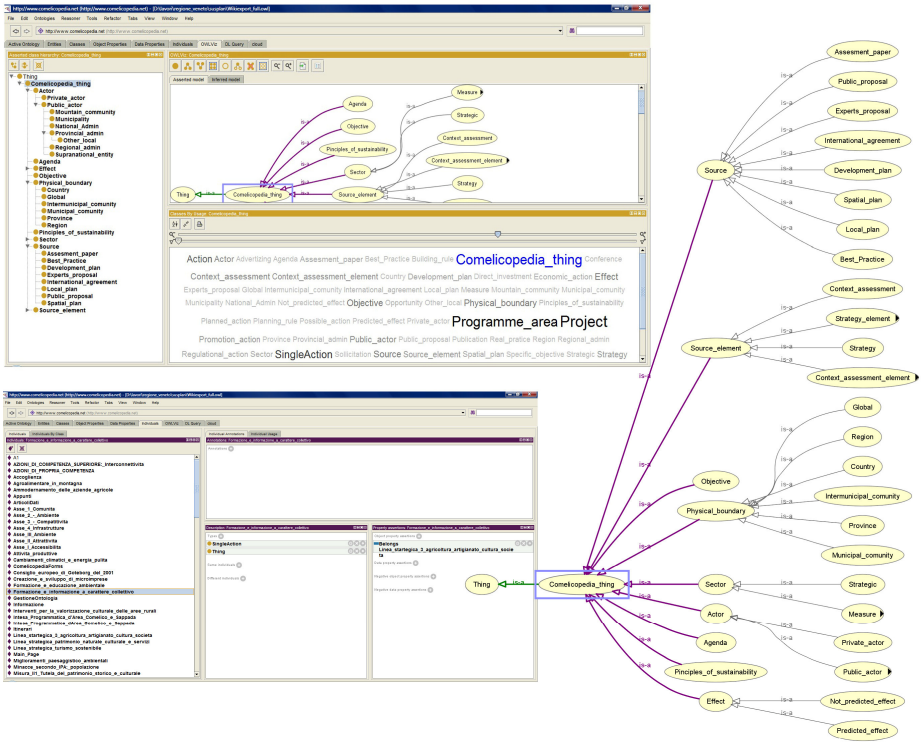

Fig. 4. Ontology structure realized with Protègé software

For descriptive purposes, each information source was divided into two trees (Fig. 4): "context assessment" tree, where all forms of analysis and representation of reality were collected (description, SWOT analysis, trend analysis, etc.), and "strategy" tree based on logical-operative chains, which contains aims and objectives and the various

ways and actions (Measures, Projects, etc.) to achieve them. The whole volume of Comelicopedia information was contained in the technological platform semantic wiki [48]. It was a collection of textual documents and hyperlinks, easily viewable and updateable by users.

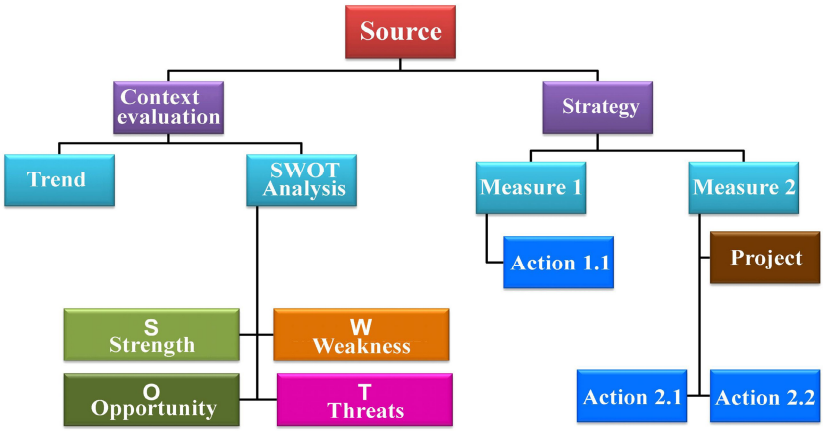

Fig. 5. Comelicopedia tree-structured knowledge

This technology can handle structuring, storing and querying by means of related ontology and via search engines based on semantics. An interesting aspect of the tool was the possibility to combine social networks [49] [50] with Semantic Web [51] [52]. Unfortunately, this aspect of the project, because of limits of time and resources, has not been fully developed. Social networks allow to involve a large number of users, in order to lead to a participatory and deliberative opening. The possibility to write comments, judgments and other contents on platform pages, has been made available, following a user registration procedure. The never solved node of platform management authority and platform free use, related to the needs of the European project have affected simple and free cooperation of stakeholders. The second aspect, related to Semantic Web technologies is based on four strengths. Information is accessible and available on the Web through simple and informative pages, like Wikipedia (hence the name Comelicopedia). The system allows a knowledge management, not simply based on an alphanumeric approach, but it works using meanings of the language, semantics. The system allows to capture, destructure and compare knowledge from multiple sources on two main aspects: the first is based on what we know about the issues (context assessment), the second one is based on what we want to do (strategy). But we had a common core ontology, which was the constant element which allowed us to compare variables that we wanted to consider. In other words, the platform was an opportunity to open both database and public policies, in order to create new cognitive frameworks for future local actions.

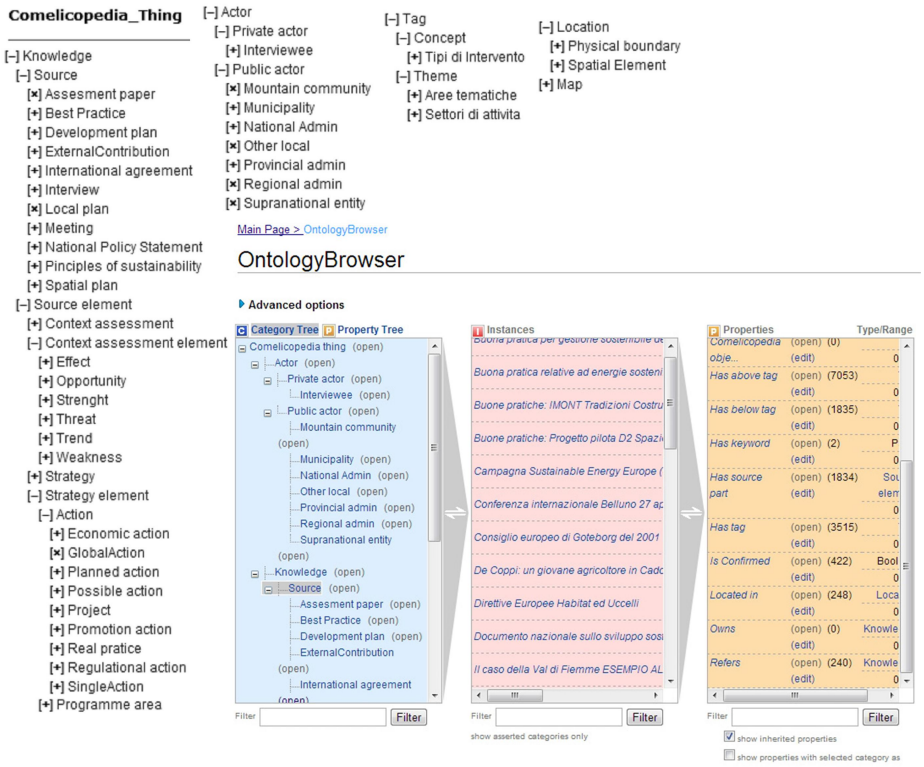

Fig. 6. Comelicopedia Taxonomy and its implementation in ontology browser

Data entry was accompanied by a system of information labelling, annotations aimed at returning contents through two classes: keywords and semantic tags. The first class, keyword, was defined a priori by the authors and arranged into two distinct hierarchical levels in the ontology.

First level keys identify thematic macro areas (environment, community, territory, economic sectors and innovation spheres), second level keys are specifications of first level keys. Both levels were extracted from Gemet Thesaurus, a technical multilingual thesaurus widely adopted in the European Union. Semantic tags could be freely inserted, by both authors and users when keywords were not enough to define page contents. The defined tags were managed by the system producing folksonomies, taxonomies with a bottom up categorization of information, integrating the original ontology [53] [54]. Finally, Comelicopedia also considered a basic level of geographic information on the places mentioned by sources.

The small encyclopedia-database was composed by: (i) ten documents of territorial policies produced by the competent authorities at various levels; (ii) interviews (or individual contributions) to experts and recognized leaders of community; (iii) a catalogue of good practice from which decision makers can take inspiration for the action; (iv) research reports prepared by the working group; (v) comments expressed by individual or associated citizens. Comelicopedia beta version consisted of approximately

800 pages; 76 keywords were defined by experts, while some users simulations had already introduced about 100 semantic tags [37]. The system is able to provide both classic type of query, related to the contents, and geographical queries. The objective of geographical queries is to satisfy requests concerning:

- Spatial distribution of contents: distribution in space of instances belonging to ontological categories, object of selection.
- Convergence between actions and context evaluations: coherence between an action or a goal located at a given point and context evaluation, into a single source.
- Spatial convergence points of view: identifying, for given locations, knowledge from various sources and their convergence.
- Spatial convergence/conceptual divergence: adequacy of various sources (figure 7).

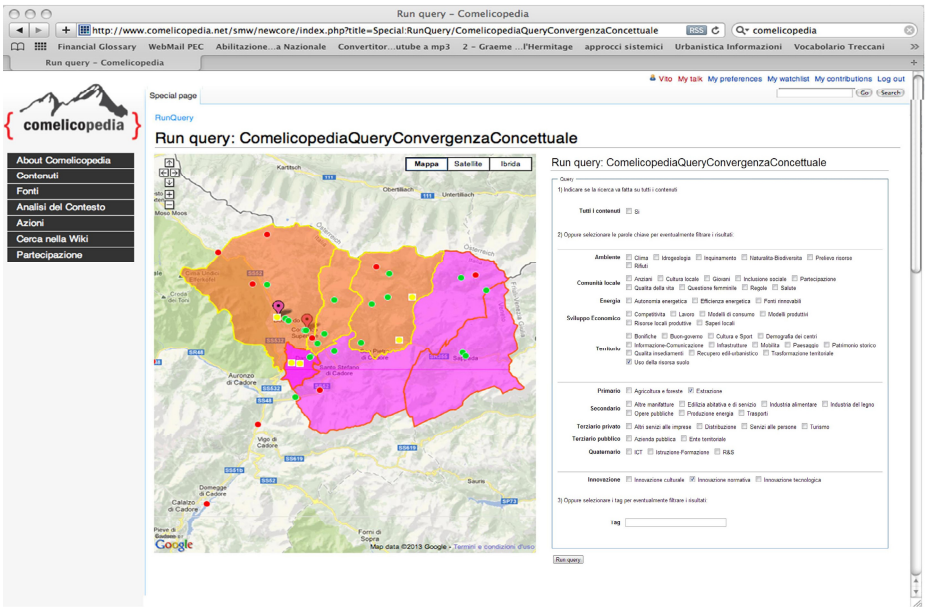

Fig. 7. An example of spatial query through spatial convergence/conceptual divergence (http://www.comelicopedia.net/smw/newcore/index.php?title=Special:RunQuery/ComelicopediaQueryConvergenzaConcettuale)

5 Results, Limits, Potentialities and Possible Future Developments

Despite Comelicopedia was a temporal limited experience and needed further research, it was an opportunity to build and manage knowledge related to decision making and to define local development policies.

Comelicopedia also allowed to evaluate some agendas and check the level of internal coherence to various instruments. It has to be noticed, for example, that the level of correspondence between context assessment and programmed actions decreases, reducing the scale of the explored source (from global to local). Tools at local scale seem inadequate to local challenges of issues identified and established at a global scale.

Comelicopedia analyzed the congruence between instruments. How much and how policies pursued at the global level dialogue with planned interventions at the local level. There are many mismatches and gaps between policies and actions, since more distant are problems identified in official documents and assessments expressed by specialists. In addition local plans completely disregard the recommendations contained in global politics.

Other times, documents at the local scale are collections of actions that have a consistency with a formal and/or ex post built strategy, following sectoral clustering of detailed actions that take place in the area, without following aims and theories of sustainability. It is possible to notice that sectoral logic, prevailing in plans, tried to integrate economy and environment over time.

The innovation found in plans is strictly related to technologies and not associated to strategies. Innovation in lifestyle and in local regulatory systems is almost completely absent. Finally, the ability of Comelicopedia to analyze semantic aspects allowed to investigate also contents assumed coherent with the definition of sustainable development. In agendas, a vision of sustainable development of the mountain is missing and the few references do not highlight an implicit pattern.

Also, use and frequency of terms related to sustainable development highlight just a theoretical approach, with weak operative feedbacks. The theme of development is mostly seen as a correction or compensation within existing institutional frameworks, rather than re-thinking institutional actions in a perspective of a new governance phase [55].

Tools such as Comelicopedia can have great potentialities in planning and decision-making, producing huge advantages achievable by a continuous use in normative dialogue between administrators and administered.

The wiki-semantic applied to the project needs to be more tested by all possible users (public employees, experts, citizens, associations, etc.): first tests show that this frontier technology can really aid to achieve a more effective stakeholders interaction in a process of policies modeling [37].

Comelicopedia can be a more effective communication tool in order to improve the dialogue between parties, if it is used not only by analysts and external experts, but also by local technicians and by those who produce data, information and knowledge.

It would be preferable to use the platform in regular daily activities, and to carry out data entry by information producers, providing directly to a continuous update. Plans and programming documents directly inserted in Comelicopedia by technical and administrative staffs of various local authorities coupled with citizens information and comments could allow, with accessible costs, the implementation of cognitive frameworks and to create permanent consultative and deliberative arenas.

There would be a better relationship between administrators and administrated producing more transparent political choices and actions and building a broader consensus on choices and a wider and informed participation.

One of the main problems occurred in project was the complexity of data entry activities, which involved few people with huge tasks. It is important to simplify this process, adopting "the principle of source proximity": the source is introduced by the producer or someone close to him, who adopts the same use of terms and semantic basin. Only in the case of historical or oral sources, specific users will be involved in data entry.

The text has to be open to future implementations by selected users, in order to avoid that a low quality of information is added. In other words, "collective intelligence" and "social control" are needed to build and implement knowledge base processes.

For a more project completeness transfer of competences to local authorities technicians for system management and creation of a core community able to stimulate discussions and implementing, updating and revising the basic information are also necessary [56]. Not great attention has been paid to GIS interface without considering a widespread use of the tool in the project.

Another error in project development, due to the limited economic resources and time, was the lack of connection and integration of platform with social networks and forums of our pilot area. Also, simply providing information about weather, local events and folklore, could attract potential users who can take part to Comelicopedia participation process. Finally, we should highlight two basic issues on which launching a debate at the international level. The first issue deals with the "linguistic dilemma". Can we have comprehensive thesauri able to work effectively at local and global level? Can these thesauri be an opportunity for knowledge management despite the semantic difference related to various languages and information sources? The second issue is related to time factor [55].

Considering that an ontology is a "specification of explicit and shared conceptualization of a domain", the question is: how to make the ontology dynamic and able to self-update? Ontology always needs a management group or it is simply enough self-organization of users. How can we change over time knowledge structures?

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