TeMA

Journal of
Land Use, Mobility and Environment

This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled “Smart City: planning for energy, transportation and sustainability of urban systems”, held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

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Journal of
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This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.

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TeMA Journal of Land Use, Mobility and Environment

EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

TeMA Journal of Land Use, Mobility and Environment

SMART CITY
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Contents

1. **The Plan in Addressing the Post Shock Conflicts 2009-2014. A First Balance Sheet of the Reconstruction of L'Aquila** 1-13
Fabio Andreassi, Pierluigi Properzi

2. **Assessment on the Expansion of Basic Sanitation Infrastructure. In the Metropolitan Area of Belo Horizonte - 2000/2010** 15-26
Grazielle Anjos Carvalho

3. **Temporary Dwelling of Social Housing in Turin. New Responses to Housing Discomfort** 27-37
Giulia Baù, Luisa Ingaramo

4. **Smart Communities. Social Innovation at the Service of the Smart Cities** 39-51
Massimiliano Bencardino, Ilaria Greco

5. **Online Citizen Reporting on Urban Maintenance: A Collection, Evaluation and Decision Support System** 53-63
Ivan Blečić, Dario Canu, Arnaldo Cecchini, Giuseppe Andrea Trunfio

6. **Walkability Explorer. An Evaluation and Design Support Tool for Walkability** 65-76
Ivan Blečić, Arnaldo Cecchini, Tanja Congiu, Giovanna Fancello, Giuseppe Andrea Trunfio

7. **Diachronic Analysis of Parking Usage: The Case Study of Brescia** 77-85
Riccardo Bonotti, Silvia Rossetti, Michela Tiboni, Maurizio Tira

8. **Crowdsourcing. A Citizen Participation Challenge** 87-96
Júnia Borges, Camila Zyngier

9. **Spatial Perception and Cognition Review. Considering Geotechnologies as Urban Planning Strategy** 97-108
Júnia Borges, Camila Zyngier, Karen Lourenço, Jonatha Santos

TeMA

Journal of
Land Use, Mobility and
Environment

10. **Dilemmas in the Analysis of Technological Change. A Cognitive Approach to Understand Innovation and Change in the Water Sector** **109-127**
Dino Borri, Laura Grassini

11. **Learning and Sharing Technology in Informal Contexts. A Multiagent-Based Ontological Approach** **129-140**
Dino Borri, Domenico Camarda, Laura Grassini, Mauro Patano

12. **Smartness and Italian Cities. A Cluster Analysis** **141-152**
Flavio Boscacci, Ila Maltese, Ilaria Mariotti

13. **Beyond Defining the Smart City. Meeting Top-Down and Bottom-Up Approaches in the Middle** **153-164**
Jonas Breuer, Nils Walravens, Pieter Ballon

14. **Resilience Through Ecological Network** **165-173**
Grazia Brunetta, Angioletta Voghera

15. **ITS System to Manage Parking Supply: Considerations on Application to the “Ring” in the City of Brescia** **175-186**
Susanna Bulferetti, Francesca Ferrari, Stefano Riccardi

16. **Formal Ontologies and Uncertainty. In Geographical Knowledge** **187-198**
Matteo Caglioni, Giovanni Fusco

17. **Geodesign From Theory to Practice: In the Search for Geodesign Principles in Italian Planning Regulations** **199-210**
Michele Campagna, Elisabetta Anna Di Cesare

18. **Geodesign from Theory to Practice: From Metaplanning to 2nd Generation of Planning Support Systems** **211-221**
Michele Campagna

19. **The Energy Networks Landscape. Impacts on Rural Land in the Molise Region** **223-234**
Donatella Cialdea, Alessandra Maccarone

20. **Marginality Phenomena and New Uses on the Agricultural Land. Diachronic and Spatial Analyses of the Molise Coastal Area** **235-245**
Donatella Cialdea, Luigi Mastronardi

21. **Spatial Analysis of Urban Squares. ‘Siccome Umbellico al corpo dell’uomo’** **247-258**
Valerio Cutini

22. **Co-Creative, Re-Generative Smart Cities. Smart Cities and Planning in a Living Lab Perspective 2** **259-270**
Luciano De Bonis, Grazia Concilio, Eugenio Leanza, Jesse Marsh, Ferdinando Trapani

23. **The Model of Voronoi's Polygons and Density: Diagnosis of Spatial Distribution of Education Services of EJA in Divinópolis, Minas Gerais, Brazil** **271-283**
Diogo De Castro Guadalupe, Ana Clara Mourão Moura

24. **Rural Architectural Intensification: A Multidisciplinar Planning Tool** **285-295**
Roberto De Lotto, Tiziano Cattaneo, Cecilia Morelli Di Popolo, Sara Morettini, Susanna Sturla, Elisabetta Venco

25. **Landscape Planning and Ecological Networks. Part A. A Rural System in Nuoro, Sardinia** **297-307**
Andrea De Montis, Maria Antonietta Bardi, Amedeo Ganciu, Antonio Ledda, Simone Caschili, Maurizio Mulas, Leonarda Dessena, Giuseppe Modica, Luigi Laudari, Carmelo Riccardo Fichera

26. **Landscape Planning and Ecological Networks. Part B. A Rural System in Nuoro, Sardinia** **309-320**
Andrea De Montis, Maria Antonietta Bardi, Amedeo Ganciu, Antonio Ledda, Simone Caschili, Maurizio Mulas, Leonarda Dessena, Giuseppe Modica, Luigi Laudari, Carmelo Riccardo Fichera

27. **Sea Guidelines. A Comparative Analysis: First Outcomes** **321-330**
Andrea De Montis, Antonio Ledda, Simone Caschili, Amedeo Ganciu, Mario Barra, Gianluca Cocco, Agnese Marcus

28. **Energy And Environment in Urban Regeneration. Studies for a Method of Analysis of Urban Periphery** **331-339**
Paolo De Pascali, Valentina Alberti, Daniela De Ioris, Michele Reginaldi

29. **Achieving Smart Energy Planning Objectives. The Approach of the Transform Project** **341-351**
Ilaria Delponte

30. **From a Smart City to a Smart Up-Country. The New City-Territory of L'Aquila** **353-364**
Donato Di Ludovico, Pierluigi Properzi, Fabio Graziosi

31. **Geovisualization Tool on Urban Quality. Interactive Tool for Urban Planning** **365-375**
Enrico Eynard, Marco Santangelo, Matteo Tabasso

TeMA Journal of Land Use, Mobility and Environment

32. **Visual Impact in the Urban Environment. The Case of Out-of-Scale Buildings** **377-388**
Enrico Fabrizio, Gabriele Garnero

33. **Smart Dialogue for Smart Citizens: Assertive Approaches for Strategic Planning** **389-401**
Isidoro Fasolino, Maria Veronica Izzo

34. **Digital Social Networks and Urban Spaces** **403-415**
Pablo Vieira Florentino, Maria Célia Furtado Rocha, Gilberto Corso Pereira

35. **Social Media Geographic Information in Tourism Planning** **417-430**
Roberta Floris, Michele Campagna

36. **Re-Use/Re-Cycle Territories: A Retroactive Conceptualisation for East Naples** **431-440**
Enrico Formato, Michelangelo Russo

37. **Urban Land Uses and Smart Mobility** **441-452**
Mauro Francini, Annunziata Palermo, Maria Francesca Viapiana

38. **The Design of Signalised Intersections at Area Level. Models and Methods** **453-464**
Mariano Gallo, Giuseppina De Luca, Luca D'acierno

39. **Piano dei Servizi. Proposal for Contents and Guidelines** **465-476**
Roberto Gerundo, Gabriella Graziuso

40. **Social Housing in Urban Regeneration. Regeneration Heritage Existing Building: Methods and Strategies** **477-486**
Maria Antonia Giannino, Ferdinando Orabona

41. **Using GIS to Record and Analyse Historical Urban Areas** **487-497**
Maria Giannopoulou, Athanasios P. Vavatsikos, Konstantinos Lykostratis, Anastasia Roukouni

42. **Network Screening for Smarter Road Sites: A Regional Case** **499-509**
Attila Grieco, Chiara Montaldo, Sylvie Occelli, Silvia Tarditi

43. **Li-Fi for a Digital Urban Infrastructure: A Novel Technology for the Smart City** **511-522**
Corrado Iannucci, Fabrizio Pini

44. **Open Spaces and Urban Ecosystem Services. Cooling Effect towards Urban Planning in South American Cities** **523-534**
Luis Inostroza

45. **From RLP to SLP: Two Different Approaches to Landscape Planning** **535-543**
Federica Isola, Cheti Pira

46. **Revitalization and its Impact on Public.
Space Organization A Case Study of Manchester in UK,
Lyon in France and Łódź in Poland** **545-556**
Jarosław Kazimierczak

47. **Geodesign for Urban Ecosystem Services** **557-565**
Daniele La Rosa

48. **An Ontology of Implementation Plans of Historic Centers:
A Case Study Concerning Sardinia, Italy** **567-579**
Sabrina Lai, Corrado Zoppi

49. **Open Data for Territorial Specialization Assessment.
Territorial Specialization in Attracting Local Development Funds:
an Assessment. Procedure Based on Open Data and Open Tools** **581-595**
Giuseppe Las Casas, Silvana Lombardo, Beniamino Murgante,
Piergiuseppe Pontrandolfi, Francesco Scorza

50. **Sustainability And Planning.
Thinking and Acting According to Thermodinamics Laws** **597-606**
Antonio Leone, Federica Gobattoni, Raffaele Pelorosso

51. **Strategic Planning of Municipal Historic Centers.
A Case Study Concerning Sardinia, Italy** **607-619**
Federica Leone, Corrado Zoppi

52. **A GIS Approach to Supporting Nightlife Impact Management:
The Case of Milan** **621-632**
Giorgio Limonta

53. **Dealing with Resilience Conceptualisation. Formal Ontologies as a Tool
for Implementation of Intelligent Geographic Information Systems** **633-644**
Giampiero Lombardini

54. **Social Media Geographic Information:
Recent Findings and Opportunities for Smart Spatial Planning** **645-658**
Pierangelo Massa, Michele Campagna

55. **Zero Emission Mobility Systems in Cities.
Inductive Recharge System Planning in Urban Areas** **659-669**
Giulio Maternini, Stefano Riccardi, Margherita Cadei

TeMA
Journal of
Land Use, Mobility and
Environment

56. **Urban Labelling: Resilience and Vulnerability as Key Concepts for a Sustainable Planning** **671-682**
Giuseppe Mazzeo

57. **Defining Smart City. A Conceptual Framework Based on Keyword Analysis** **683-694**
Farnaz Mosannenzadeh, Daniele Vettorato

58. **Parametric Modeling of Urban Landscape: Decoding the Brasilia of Lucio Costa from Modernism to Present Days** **695-708**
Ana Clara Moura, Suellen Ribeiro, Isadora Correa, Bruno Braga

59. **Smart Mediterranean Logics. Old-New Dimensions and Transformations of Territories and Cites-Ports in Mediterranean** **709-718**
Emanuela Nan

60. **Mapping Smart Regions. An Exploratory Approach** **719-728**
Sylvie Occelli, Alessandro Sciullo

61. **Planning Un-Sustainable Development of Mezzogiorno. Methods and Strategies for Planning Human Sustainable Development** **729-736**
Ferdinando Orabona, Maria Antonia Giannino

62. **The Factors Influencing Transport Energy Consumption in Urban Areas: a Review** **737-747**
Rocco Papa, Carmela Gargiulo, Gennaro Angiello

63. **Integrated Urban System and Energy Consumption Model: Residential Buildings** **749-758**
Rocco Papa, Carmela Gargiulo, Gerardo Carpentieri

64. **Integrated Urban System and Energy Consumption Model: Public and Singular Buildings** **759-770**
Rocco Papa, Carmela Gargiulo, Mario Cristiano

65. **Urban Smartness Vs Urban Competitiveness: A Comparison of Italian Cities Rankings** **771-782**
Rocco Papa, Carmela Gargiulo, Stefano Franco, Laura Russo

66. **Urban Systems and Energy Consumptions: A Critical Approach** **783-792**
Rocco Papa, Carmela Gargiulo, Floriana Zucaro

67. **Climate Change and Energy Sustainability. Which Innovations in European Strategies and Plans** **793-804**
Rocco Papa, Carmela Gargiulo, Floriana Zucaro

68. **Bio-Energy Connectivity And Ecosystem Services. An Assessment by Pandora 3.0 Model for Land Use Decision Making** 805-816
Raffaele Pelorosso, Federica Gobattoni, Francesco Geri, Roberto Monaco, Antonio Leone

69. **Entropy and the City. GHG Emissions Inventory: a Common Baseline for the Design of Urban and Industrial Ecologies** 817-828
Michele Pezzagno, Marco Rosini

70. **Urban Planning and Climate Change: Adaptation and Mitigation Strategies** 829-840
Fulvia Pinto

71. **Urban Gaming Simulation for Enhancing Disaster Resilience. A Social Learning Tool for Modern Disaster Risk Management** 841-851
Sarunwit Promsaka Na Sakonnakron, Pongpisit Huyakorn, Paola Rizzi

72. **Visualisation as a Model. Overview on Communication Techniques in Transport and Urban Planning** 853-862
Giovanni Rabino, Elena Masala

73. **Ontologies and Methods of Qualitative Research in Urban Planning** 863-869
Giovanni Rabino

74. **City/Sea Searching for a New Connection. Regeneration Proposal for Naples Waterfront Like an Harbourscape: Comparing Three Case Studies** 871-882
Michelangelo Russo, Enrico Formato

75. **Sensitivity Assessment. Localization of Road Transport Infrastructures in the Province of Lucca** 883-895
Luisa Santini, Serena Pecori

76. **Creating Smart Urban Landscapes. A Multimedia Platform for Placemaking** 897-907
Marichela Sepe

77. **Virtual Power Plant. Environmental Technology Management Tools of The Settlement Processes** 909-920
Maurizio Sibilla

78. **Ecosystem Services and Border Regions. Case Study from Czech – Polish Borderland** 921-932
Marcin Spyra

79. **The Creative Side of the Reflective Planner. Updating the Schön's Findings** 933-940
Maria Rosaria Stufano Melone, Giovanni Rabino

TeMA
Journal of
Land Use, Mobility and
Environment

80. **Achieving People Friendly Accessibility.
Key Concepts and a Case Study Overview** **941-951**
Michela Tiboni, Silvia Rossetti

81. **Planning Pharmacies: An Operational Method to Find the Best Location** **953-963**
Simona Tondelli, Stefano Fatone

82. **Transportation Infrastructure Impacts Evaluation:
The Case of Egnatia Motorway in Greece** **965-975**
Athanasios P. Vavatsikos, Maria Giannopoulou

83. **Designing Mobility in a City in Transition.
Challenges from the Case of Palermo** **977-988**
Ignazio Vinci, Salvatore Di Dio

84. **Considerations on the Use of Visual Tools in Planning Processes:
A Brazilian Experience** **989-998**
Camila Zyngier, Stefano Pensa, Elena Masala

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THE PLAN IN ADDRESSING THE POST SHOCK CONFLICTS

2009-2014. A FIRST BALANCE SHEET OF THE RECONSTRUCTION OF L'AQUILA

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ABSTRACT

Five years after the earthquake in Abruzzo in 2009 it is possible to draw up a first balance sheet of the public actions carried out so far in relation to reconstruction. The transformations undergone by L'Aquila and the territory of Abruzzo impose a re-reading of the institutional framework and of the role that the Plan can have in addressing the conflicts deriving from the physical and social reconstruction of the regional capital. But the joint presence of many and various litigious actors makes it complex to adopt a new season of projects able to make the most of the substantial public financing and to direct this towards agreed models of urban development. Moreover a comparison with the effectiveness of public actions that may be observed in analogous cases in the urban history of L'Aquila makes the picture even more alarming.

KEYWORDS

L'Aquila, Shock, Plans, Urban history

1 INTRODUCTION

The intention of the present research is to analyze the role of the Plan in managing the conflicts that affect urban settlements after shocks of natural or human origin such as for example earthquakes, floods, landslides, wars and social or economic crises. The ensuing urban transformations may be seen as indicators of the state of health of town planning as a discipline and, specifically, of its capacity to respond effectively to the new needs. The case study of L'Aquila can be of interest because throughout its history it has undergone numerous serious earthquakes (1315, 1349, 1462, 1703, 1915, 2009) in addition to several social shocks, among which the most recent one in 1971 due to the birth of the Regions, with the consequent epiphany of the conflict between the coastal areas and the interior. Five years after the earthquake in 2009 and with the economic crisis still in full swing, it is possible to draw up a balance sheet of the ways in which the post-shock has been tackled and to make a start on overcoming the difficulties encountered from the standpoint of physical and social reconstruction in keeping with urban history and in line with the demand for new social development models in which environmental sustainability and urban technological innovation are among the possible objectives.

2 THE PLAN AND THE CONFLICTS IN THE 20TH CENTURY

It is curious, but the city of L'Aquila in the last century started and effectively completed the season of plans always after conflicts caused by the shocks that have so violently characterized social history and spatial conformation (Andreassi, 2012a). Following the earthquake in February 1915 a planning process immediately started up with the aim of managing the phase of the city's reconstruction and growth. A study commission was installed and undertook various activities of public interest on aspects of reconstruction, giving rise to a series of proposals whose partiality, while bringing about their failure, prepared the field for the drawing up of a successive more complex plan (Properzi, 2010). It was only after two years, in 1917, that the master plan drawn up by the engineer Giulio Tian was approved; he was a foremost figure in the national framework in this discipline, having also drawn up the plans for Ancona and Taranto. Management was placed in the hands of a municipal planning office which produced a series of variants to adapt it to the new post-World War I society and the subsequent authoritarian developments. The Second World War did not cause any damage to the city. The ensuing building boom in the 50's and 60's was managed mainly with the projects. The timid attempt to draw up a new master plan made by Luigi Piccinato in the 60's was undermined[1] by a society more and more intent upon the friendly management of transformation processes and did not look kindly upon the publicity of the objectives set out in the plan (Piroddi & Clementi, 1988). It was necessary for another conflict to occur, to give an effective fresh start to the planning season. Following the decision to carry out the constitutional indications regarding the country's institutional architecture[2], in 1971 the problem again arose[3] of the birth of the Regions and, consequently, of the choice of regional

1 The plan was adopted twice before being shelved without being finally approved. The first adoption took place on 31 July 1962, and the second one, after being examined by the Ministry of Public Works, took place on 26 July 1965.

2 Law no. 108/1968 started the real constitution of the Regions with ordinary statutes.

3 In 1949 the authority of the Hon. G. Spataro from Vasto, co-founder of Christian Democracy, came into play in the commission of the Chamber of Deputies engaged in defining the regional capitals. On this occasion the contrast started between L'Aquila and Pescara, temporarily settled in favour of L'Aquila after the popular uprising and the Demochristian controversy between the Hon. E. Viola and G. Spataro.

capitals. The political and social events of the time led to the revival of the *audaciam aquilanorum*[4] with the so-called uprisings that took place between 26 and 29 February 1971 (Petruccioli, 2011). Barricades were erected in the city along the main access thoroughfares, and the party headquarters and the houses of the foremost local politicians were set on fire, as they were claimed to be guilty of having *betrayed* the claims of local society and of having accepted the dispersion between Pescara and L'Aquila of the administrative and representative offices of the Region being constituted, while confirming the title of regional capital for the latter city. The intervention of the forces of law and order and of the army brought back a semblance of peace but nevertheless failed to subdue the general malcontent which instead came to a natural end with the starting of the planning season. It should be observed that thanks to this the political class again found and reconquered a role in society, which had been lost on the occasion of the definition of the regional institutional architecture. The plan[5], the drawing up of which was started in 1972, just one year after the shock as on the occasion of the preceding one, was viewed as an instrument to recreate the social cohesion seriously threatened by the difference between the *realpolitik* and the claiming of past roles put forward by the city and no longer shared by the majority of the inhabitants of Abruzzo. For the drawing up process, techniques of participation were tried out, both direct, with the involvement of the district and ward councils by means of convening 250 public assemblies, and indirect, thanks to the extending to a large number of citizens of the benefits of the *graphics economy*[6] deriving from the combined effect of the low density and the overdimensioning of requirements. Seen in this light, the PRG (Land Use Plan of the Municipality) can be regarded as a monument of the city, in bearing witness to the post-shock social reconciliation. In time however it suffers a growing deficit of effectiveness. It foreshadows a development model rapidly being outdated, being based substantially on the possibilities offered by the motorway link with Rome, by the national industrial plants shortly due to close down, and by the expectations of the revival of the mountain economy regulated by the coeval law that established the short-lived *Comunità Montane*[7].

3 THE PAX ABRUZZESE

The regional institutional conformation and the Aquilan PRG contributed towards the *Pax Abruzzese* lasting from 1971 until 2009, during which period the city underwent considerable economic development inserted in that of the Abruzzo region. In the 1951-1963 period the region's net per-capita income was lower than that of the *Mezzogiorno* (Southern Italy and Islands) and almost 35 points less than the national average. In 1970 it reached 72.8% and Abruzzo continued to rise above the average south Italian value which stood at 68.9%. The establishment of heavy industry of external origin, SIV at Vasto and Siemens at L'Aquila, constituted the first great moment of severance from an Abruzzo looked upon in terms of being a reservoir of Manpower for the North and as a *poor* component of the Italian *Mezzogiorno* (Bodo & Viesti, 1997). After

[4] A warning thought to have been incised on a scroll in the fifteenth-century castle, in its turn erected at the expense of the city as punishment for the rebellion against Spanish power.

[5] In 1972 the first phase of government of the territory came to a rapid conclusion with the approval of the Building Programme, preparatory to the subsequent drafting of the PRG adopted in 1975 and finally approved in 1979.

[6] A term coined by Luigi Scano intending the objective of accumulating the revenue deriving from the variation in the land regime determined by the PRG rather than being based on the profitability of the building measure, in other words profitability of the building measure, interested, that is to say, more in the increase in value derived from allowing building to take place on land than in achieving the permitted volumes.

[7] This is Law no. 1102/1971 which imposed on predetermined municipalities the constitution of the Comunità Montane (Mountains Community) for the drawing up and carrying out of development programmes and of the territorial plans of the respective upland areas for the purpose of a general policy of economic and social rebalance.

1970 an acceleration occurred in the growth of the GDP which reached its highest peak in 1992, when its distance with respect to the rest of the country was down to 9.5 points. So that «putting the Italian average value at 100, the GDP increased by 33% in the span of 50 years, transforming Abruzzo from one of the last to the first Region in the Mezzogiorno as opposed to what happened in the Mezzogiorno itself, whose value remained practically unchanged» (Mauro, 2001). Feeding the region were the Community financing measures for depressed areas and the spending capacity guaranteed by State transfers (ex Objective 18). L'Aquila still lived thanks to the a-systemic growth of the University, to the over-dimensioning of the GDP, drugging both the building cycles and the processes of providing financing for the territory, the latter being amplified as from the 90's by the new town planning policies of the Municipal Council (referred to below as MC). The University followed quantitative objectives[9] with a repeated increase of 80% on a 10-year basis of students enrolled, welcomed by the city thanks to the revenue benefits deriving from the demand of temporary rents and from the consequent housing cycles financed by the banks. The MC instead initially linked the government control of urban transformations in the carrying out of the residential part of the PRG with the boom in low-cost and council housing. Throughout the 70's and the early 80's the public housing measures and the subsidized private ones succeeded in covering 40 % of the housing demand thanks to public contributions amounting to 25 billion lire (Properzi, 2010). In the 90's the drift began with recourse to returns through municipal property taxation applied to building lands, leading to a public speculative approach with grave processes of cheap sales of agricultural land in order to cope with balance sheet demands. The PRG in fact was the object of variants both from parastatal initiatives10, and private ones as from 1995 during the period of so-called negotiated town planning11. The crisis exploded at the end of the 90's when the failure of the mountain economy became apparent (CRESA, 2002) and the benefits of exogenous measures on the industrial economy deriving from state public action came to an end: neither of them fully replaced by the endogenous capacities of society and of the territory.

4 THE TWO EARTHQUAKES

In the three-year period 2009-2012 there was a double earthquake, the physical one that struck highland Abruzzo and in particular the historic centre of the regional capital, and the economic one linked to the complex processs of the *spending review* which concerned all the local public agencies. Both earthquakes caused fresh conflicts, redefined the terms of territorial government and imposed a new season of projects.

The earthquake of 6 April 2009 struck an area of 2387 sq. km in upland Abruzzo distributed over 57 municipalities within what is termed the *crater*, affecting a total population of 144,757 persons, about half of them living in L'Aquila. After this it was sought to tackle the problems of reconstruction with a series of disciplinary activities[12] right from the month following the quake, but there has been no response to these in

8 The EU pursues the objective of social and economic cohesion with actions of financial solidarity towards the most disadvantaged regions which have a per capita GDP of less than 75% of the Community average and calculated by Eurostat on the basis of the statistical territorial units. Abruzzo moved out of Objective 1 with the Inter-ministerial decree of 05/08/1994 issued by the Minister of Labour and Social Security in concert with the Minister of the Treasury, the Budget and Economic Programming.

9 Number of students enrolled in degree courses in the Academic Year: 1980-81, 4118; 1990-91, 7884; 2000-01, 14.772; 2010-11, 25.224. Data provided by L'Aquila University – Statistical Observatory sector.

10 By way of example, prisons, barracks and university sites are being built in valuable agricultural areas, thanks to art. 81 of DPR (Presidential Decree) 616/1977.

11 Variants are observed to implement hotel capacity, for the development of industrial and commercial areas, and for the opportunities offered by the PRUSST and Integrated Plans

12 See the Manifesto of Town Planners published by INU in May 2009, the conference entitled *After the emergency towards reconstruction* organized at L'Aquila by INU on 23 September 2009, the book ed. by

public actions due more to deafness than to aphonia. On the other hand considerable publicistic activity has started on the question of reconstruction[13] and in this a number of contributions have been meekly inserted, on the following themes:

- the relation between the emergency and right to the city (Andreassi, 2012a);
- delegitimization of the Plan following neo-liberalist approaches typical of laissez faire, and the provision of financing for the territory (Andreassi, 2012b);
- increased financing of the system of historical and architectural values (Andreassi, 2012c);
- the role of the big public patrimonies (Andreassi, 2012d);
- the role of public spaces (Andreassi, 2013a; Andreassi & Di Lodovico, 2013b);
- the relation between memory and risk (Andreassi & Aristone, 2013c).

The earthquake in April 2009 accelerated the economic decline, modified the social and economic imbalances[14] and destructured the characteristics of the physical city through the urbanization of the agricultural territory, indifference to the landscape aspect and through numerous public and private delocalization processes not governed by local public action, bringing about the disarticulated relocation of the rare functions without verifying their effects on the urban structure. The report dated 8 June 2010 states for the municipality of L'Aquila 31,590 inhabitants assisted of a total of 73 thousand residents, equal to 43%. The report of 5 March 2014 mentions 19,001 inhabitants still receiving assistance equal to 26% of the total population, but in relation to just the assisted population, there is a reduction of barely 37%. In other terms in these last four years only 12,589 inhabitants out of 31,000 receiving assistance have gone back home, whereas the population not assisted has increased by 17%, hence the permanence of temporary housing which can become definitive.

Even more dramatic is the ineffectiveness of the governance adopted to cope with the emergency and the ensuing commissarial phase of the reconstruction governed by law no. 77/2009. In the initial emergency phase which ended on 31 January 2010 operations were carried out by the *Protezione Civile* (Civil Defence), advised by the local councils. Subsequently, until 31 August 2012, the regional Commissioner in charge of reconstruction took over. To date 77 ordinances have been produced by the Prime Minister's Office and 143 decrees of the Commissioner, totalling 220 administrative acts, but there has not been a single regional law on reconstruction. In addition there have been 57 Reconstruction Plans[15] as imposed by law no. 77/2009, which however concern only the historic centres, while the reconstruction of the settled areas outside of these takes place through simple building processes carried out with private law procedures, in which the

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LAURAQ, INU, ANCSA, *Dio salvi L'Aquila. Una ricostruzione difficile* containing the proceedings of 8 workshops on a single theme with the participation of 150 experts who addressed the theme of reconstruction in various aspects. Following this two conclusive forums and two design workshops have been organized, the first one in 2011 and the second one in 2014, whose scanty effect stems from the unaccepted participation of expert knowledge in the first phase of reconstruction.

[13] Reference is made to the archive of the *Deputazione di Storia Patria degli Abruzzi*, born with the objective of compiling a list, as complete as possible, of the exceptional scientific, divulgative and critical publicistic activity produced by the Abruzzo earthquake.

[14] The productive structure is characterized by the presence of multinational companies operating in the chemical, pharmaceutical and electronic sectors and, on the other hand, by small specialized enterprises mainly of family type and operating in the commercial, agricultural and building sectors. The earthquake had effects on the productive cycle, determining three types of costs: direct, caused by the destruction of the capital; indirect, deriving from the suspension of working activities; and induced, deriving from the impacts caused in the entire economic system.

[15] At 27 February 2014 of the 57 municipalities in the Crater availing themselves of the Reconstruction Plan, the situation is: 11 with an approved RP; 14 with the RP in the process of being approved; 21 with an RP adopted; 9 with the RP drawn up; and 2 with the RP yet to be drawn up.

only assessment indicator of possible substitution is of financial and not urban planning type[16]. Furthermore the single MAs are entitled to decide whether the Reconstruction Plan is of urban planning or strategic type on the basis of an uncertain *judgment of suitability* of the PRG in force with regard to reconstruction aspects. Hence strategic plans are drawn up for minor historic centres with 300-500 inhabitants, whereas the MA of L'Aquila does not consider that the earthquake caused damage in the city sufficient to warrant revising the current PRG of 1975 and making the Reconstruction Plan an urban planning one. Remaining in force are outdated, paradoxical norms foreseeing for instance that the value of buildings depends on geography, which means that those located in Zone A of L'Aquila are subject to building restoration, while those in Zone A in the outlying districts undergo transformations permitted for building restructuring works.

With law no. 134/2012 the governance changed, oscillating from the privatistic model of law 77/2009 aimed at experimentation of new, improbable operative structures of the state in which the emergency is likened to great events, to a pseudo-publicistic centralistic model. Now apparently without a Commissioner, management again became of ordinary type by the MC and two special offices were set up for the administrative, technical and accounting management of reconstruction. The first one (USRA) is concerned solely with the municipality of L'Aquila and the second one (USRC) deals with the other municipalities in the crater. Two sets of parameters were issued, one valid for L'Aquila and the other one for the remaining municipalities, with the objective of controlling the reconstruction of each single housing unit coming under the Reconstruction Plan with measures that regard its pre-project physical aspect. The aim is to predetermine the contribution that can be granted using parametric data. To analyze a building in the municipality of L'Aquila consisting of 10 housing units, for example, it is necessary to insert 618 elements. Slightly fewer for the centres in the rest of the crater[17]. In this way the deforming effects are measured on the public management of the post-shock conflict, an administrative approach being preferred to a problem in reality primarily of town planning type.

The reconstruction process has almost been completed in the peripheries: at L'Aquila 90% of all private buildings have been completed, in the other centres in the crater the percentage is somewhat lower, up to 70%, but the prevailing solution has been substantially the same considering that in the agenda of public actions there are no town planning problems, only financial ones. Thus a city has been reconstructed with a building construction approach, again proposing the same town planning problems: insufficient porosity, the absence of a functional and morphological mix, autistic public spaces, absence of neighbourhood units, incompleteness of infrastructures, absence of slow mobility, non-thematization of open spaces and broken-up spatial conformation. The financial approach has moreover permitted the loss of many buildings of architectural value and built as from the 50's. Lacking any regulation they have been demolished and replaced by a poor type of ordinary buildings or ones irremediably altered:

- the Ina Casa neighborhood of S. Barbara and of S. Francesco both built in the 50's at the neorealistic design of Enrico Lenti and others (substituted);
- the Lawcourt, designed by Enrico Lenti and Elio Piroddi and others in 1962. In/Arch Award 1966 (altered);
- the Iacp houses designed by Luisa Anversa and others in 1981. In/Arch Award 1985 (substituted);
- the terraced houses designed in 1989 by the Luigi Zordan, In/Arch Award 1990 (substituted);

[16] The open letter of 09/04/2014 addressed to the Mayor of L'Aquila by the President of INU, Silvia Viviani.

[17] The buildings in the historic centre of L'Aquila, excluding churches, number 1910, and for the other districts the number increases to 2754. It is not yet possible to know the total number of buildings in the rest of the crater for which the form has to be compiled. It is presumed there must be 15 thousand.

- the head office of Inail, built in 1940 according to the rationalist design of Luigi Ciarlini. This is a building of historical value whose demolition was authorized with a faithful reconstruction in its external perception.

In conclusion, the post-shock management of the conflict has led to a galaxy of instruments without any overall rationality as to territorial governance and the development model to be pursued. The reconstruction that has prevailed was carried out with public funds but without any effective public coordination, without a specific regional law[18] and without any area plan for the crater. Instruments of technical-administrative assessment of the building process have increasingly prevailed rather than those of urban planning assessment of the reconstruction of a city. In other words the public actors have preferred the excessive production of acts that have proved ineffectual in creating a framework for balanced public policies according to the necessary neo-contractual criteria (sharing of rules) and ones of neo-utilitarian type (shared objectives). Lastly the effectiveness of the public actions that characterized the city-shock-plan relationship in the last century has been betrayed.

In 2010 the region suffered a second earthquake, this time of economic type, and the consequent echo of the 2008 crisis. The enforced reduction in public spending has given rise to numerous regroupings of the health units (ASL)[19], of the *Comunità Montane*[20], of the Provinces (in itinere)[21] and of other linked or instrumental agencies in the Region which simultaneously takes over their functions and human, financial and instrumental resources[22], also with operations of rearrangement and mergers[23]; but the objectives of reducing public spending and of the tax burden, as well as the new weights and the new roles of the towns and of the territory disconcerted by the normal processes of polarization of urban functions, make the current instruments of planning territorial governance outdated[24].

4 RETURN TO THE GOVERNMENT

In this framework the central government intervened with law no. 134/2011, announcing a review of the role which the State has in the event of calamities which call for its financial intervention. On the basis of the principle of its responsibility and transparency to Italian taxpayers it intervened in a direct manner in the configuration of development models and planning choices foreshadowing central substitutive measures, in view also of the ineffective nature of local public actions. It is interesting to observe this return to *government* processes in which central state organs take action in determining specific objectives and in the project-making of local agencies by virtue of the power stemming from being the body that disburses the

18 Several times requested by INU and by a number of regional councillors.

19 In 2010 the number of health units decreased from 6 to 4.

20 By the C.R. Resolution of 29.06.2010 the number of *Comunità Montane* goes from 19 to 11.

21 The legislative procedure relating to the unification of the Provinces was brusquely interrupted by the end of the government (2008-13). In the present legislature the question has been taken up again although in different ways and with different times still to be defined.

22 The Regional Law of 30/2010 has closed the *Azienda Regionale per l'Edilizia e il Territorio*, that of 30/2011 has closed the *Ente Abruzzo Lavoro*, that of 32/2011 has closed the *Agenzia di Promozione Turistica Regionale*, and that of 29/2011 has closed the *Azienda Regionale per i Servizi di Sviluppo Agricolo*.

23 The six Optimal Territorial Areas (ATO) of the water sector were merged into a single regional ATO; the seven Consortiums for Industrial Development were merged in a single Regional Enterprise for Productive Activities; and the number of *Confidi* was reduced from 78 to 10.

24 The current Regional Reference Framework (QRR) in force was approved by CR no. 147/4 in 2000. The current Regional Landscape Plan was drawn up in 1990 and updated in 2004. The new landscape plan has not yet been fully authorized. The present Regional Town Planning law dates from 1983, still based on the Land Use Planning (PRG).

financing. In other terms, a *soft* modification is attempted of the principle of subsidiarity[25] of local autonomy in governing the territory concerned. Instrumental to this objective are two studies promoted by the Minister of Social Cohesion. The first one is intended as an aid in decision-making processes in a hoped-for strategic plan of economic development (Calafati, 2012), also aimed at a new *smart city* (OECD, 2013)[26], while the second one intervenes in the question of the municipal planning of L'Aquila (Oliva, 2012).

The first study confirms that even before the earthquake the city suffered from a dyscrasia between settlement processes and the framework of public actions. The processes of spatial polarization and of territorial integration that have taken place in Abruzzo since the 50's have not been accompanied by any corresponding institutional adaptations, generating the current discrepancy between functional and housing organization and territorial political and administrative organization[27]. The phenomenon has been neglected of the formation of inter-municipal territorial systems which have acquired the character of *de facto* city, as, for example, the first Abruzzo demographic pole corresponding to the Pescara and Chieti coastal area[28]. Wholly to the advantage of the towns considered more attractive and to the disadvantage of those, like L'Aquila, that do not succeed in introducing new rare functions, or in increasing the weight of those that exist, and are therefore incapable of increasing their competitiveness. That the city was already in decline before the earthquake of 2009 was considered a certainty by specific scientific disciplines[29], but not by local society which sat back and enjoyed the tranquillity offered by being an administrative city with increasing financial revenues, only partly declared fiscally, guaranteed monthly by the 9 thousand university students not local residents but permanently staying in the city[30]. At the same time the post-earthquake situation can be understood as a resource in consideration of the substantial amounts of public financing that make the city and the crater competitive compared with other urban areas that have to overcome both the economic difficulties deriving from the country system, and those stemming from a generalized process of polarization of resources and expectations of life. For the emergency phase and for the reconstruction of the material damage alone 12 billion euro have so far been spent, out of a foreseen total of 18 billion euro, i.e. an expenditure of 124 thousand € per inhabitant.

The importance that such financing can have in defining an economic development capable of reducing vulnerability is interesting. The increased income improves the general conditions of social security (Wildavsky, 1988) and can generate an added demand for earthquake protection, thus triggering a process of self-supply qualifying the development model and reducing exposure to future calamitous events (Albala Bertrand, 1999); but in the absence of a social development model to receive public resources intended for reconstruction there is the risk that, *at the end of the day*, little of what has been spent will remain in the

25 This principle was inserted in art. 118 of the Italian Constitution thanks to law no. 3/2001 entitled: Amendments to Title V of the second part of the Constitution.

26 The document prepared by Calafati and others in 2012 subsequently formed part of the study for a new smart city, drawn up by an OECD research team and the University of Groningen, financed by the Department for Development and Economic Cohesion of the Ministry of Economic Development, within the National Operative Programme, Governance and Technical Assistance FESR 2007-2013, and by the Abruzzo Committee formed by the regional union representatives of Confindustria, CGIL, CISL and UIL.

27 Reference may be made to the Document for the processing of the territorial projections of the DSR, edited by URBIT/INU in 2006 on behalf of the Abruzzo Region, following the convention of 22.12.2005 (no. 2099/SEGR) between the latter and MIITT.

28 Between 1961-2011 the coast towns underwent considerable population increases (Pescara + 41%; Montesilvano + 309%; Spoltore + 152%; San Giovanni Teatino +201%, Francavilla a Mare + 121%, Chieti +12%) for a total in 2011 of about 280,000 inhabitants, considerably more than in the L'Aquila area (L'Aquila +29%, Scoppito +69%, Pizzoli +42%) with currently about 80,000 inhabitants.

29 Reference is made to the substantial publications of CRESA.

30 Assuming a monthly spending capacity of 600 €/student to be used mainly for board and lodging and for social life, there is a revenue for the city of 54,000,000 €/year.

city to be earmarked for post-reconstruction investments and much will be diverted to other sectors economically more remunerative. To avert this danger, in the first study (Calafati, 2012) various scenarios are proposed, starting from the strong points of the *status quo* according to an approach that links the action of the strategic plan to the city's preexisting economic vocations (administration and research). This is a work with an initial, limited approach to the problem in the sense that it does not foresee the introduction of new economic and functional variables but tends to make the most of existing ones, and at the same time inviting local bodies to recalibrate their actions on the basis of the new post-earthquake settlement pattern within the crater. The Region is invited to redefine the role and the weight of its capital with the updating of its programming, legislative and constituent documents, having considered that the polarization process under way for the last twenty years in the coastal strip around Pescara and in the mountain area around L'Aquila and Teramo, increases the level of territorial complexity and competitiveness, but at the same time brings about a review of the choices of location of the regional offices in the light of the guiding functions of each urban centre. To the Province is posed the problem of reviewing its territorial planning both due to the effects of the forthcoming institutional unification, and to the guiding role that it can meanwhile assume in drawing up territorial plans for the crater[31]. To the adjacent Municipal Councils to the regional capital, Calafati poses the problem of reviewing their administrative and planning autonomy to the advantage of a joint government of the territory, in view of the pernicious effects caused to them by the central role assumed by L'Aquila, which has drained resources and development potential from them. The MC of L'Aquila is asked to propose itself as *primus inter pares* in a territory that stretches beyond its administrative boundaries, to draw up jointly many thematic strategic plans, in which participation and sharing are present in every phase of elaboration, in which those putting forward their interests fully and jointly participate in drawing up the plan and are joint signatories of all the documents produced (initial, interim and final). Coming into this pattern is the good practice of setting up a promoting committee to receive the adhesion on a voluntary basis of the public and private bodies concerned, before starting on the actual drawing up of the plan, in which the MC may (and not must) be present. The strategic plan should therefore be a political/programming document aimed at forming coalitions around general, simple, selective choices (Mazza, 2003) and with operative commitments.

In this case, too, the MC disregarded the indications during the revision of its strategic plan, begun in 2008 and reviewed in 2012 following the effects of the earthquake[32]. It decided to operate autonomously and in solitude, presenting a self-referential model of a strategic plan[33], with dangerous derive foreshadowing a number of new urban spatial elements and with an equally dangerous reduction of the principle of self-determination in governance of the territory. The proposed plan is self-referential[34] because it is an instrument produced in solitude by the MC, adopting instruments and methods of consultation propaedeutic to the drawing up of traditional plans and not consensual processes of wide-ranging participatory plans. In fact the phase of confrontation (and not of joint drawing up) was concentrated in just three seminars which were held very close to each other, on 5, 7 and 12 March 2012 and just before the administrative elections, thereby downgrading the plan to an instrument of party confrontation. Very different instead is the

31 See the Methodological Document of 14.12.2011 drawn up by P. Properzi and relating to the Territorial Plan of the Province of L'Aquila, now being updated.

32 The Strategic Plan in force was drawn up by D. Iacovone, S. Pasanisi, P. Urbani, the Censis Foundation.

33 http://www.comune.laquila.gov.it/pagina196_il-piano-strategico.html (last access 05/12/2013).

34 Explicative of this self-referentiality is the declaration reported in the premise of the Strategic Plan confirming that «the programmatic contents of the document are furthermore the outcome of the constant confrontation with the Mayor Massimo Cialente».

formative process adopted in other situations, demonstrating that the strategic plan is an instrument around which a network of alliances can be constructed:

CITY	PROMOTER	NUMBER OF FOUNDER MEMBERS (YEAR)	NUMBER OF ADHERING MEMBERS IN 2014
Bologna	Promoting Committee	3 (2011)	34
Venice	Cultural Association	67 (2004)	67
Alessandria	Cultural Association	16 (2009)	63
L'Aquila	Municipality of L'Aquila	1 (2008)	1

Tab.1 Table of membership in some Italian strategic plans

The MC's plan foresaw moreover the formation of an external Consulting body which although «without overstepping the limits of the municipal organs» should interface exclusively with the Mayor and could follow the process of final drawing up, execution and monitoring, while execution is delegated to a new special office. But the will to carry out *ex post* the «coalition formation process» (Mazza, 2004) weakened its effectiveness. More complex is the spatial trend, because in spite of being aware that the regional town planning law in force does not foresee it as a conforming instrument of the territory, the strategic plan foreshadows spatial solutions with 18 urban projects located within the city walls and in its immediate vicinity, with the objective of obtaining prior consensus for the future compulsory council passages for the approval of the single variants. It was thus intended to bypass – with the consensual processes typical of the strategic plan which are of a political nature – the phase of regulation and conformation of the planning which translates into the quantitative and dimensional verification of needs, analyses of the context of the single project, and interactive ones between the single projects, as well as between these with the city and the territory. Equally complex is the reduction of the principle of territorial self-government. The MC accepted that determination of the objectives of the strategic plan are suggested by the financing government agency, destructuring in that way the urban planning DNA of the city which considers the plan the prime instrument for recomposing social cohesion from below, above all at certain extraordinary moments of its history.

Just as determination of the objectives of the strategic plan is suggested by the first study, the physical reconstruction of the city must take place with a «model of town planning operative for projects which, as moreover emerges from the various contributions drawn up in the last few months by various institutions, starting with the experts appointed by the Minister of Territorial Cohesion, appears the most suitable way of tackling the reconstruction of a city destroyed by the earthquake» (Oliva, 2012), thus foreseeing a series of precise variants pending a specific regional law. The second study thus starts from the openings of the first one, justifies the strategic nature of the Reconstruction Plan and prefigures the prospects of city development through the formation of new Plan models. It advises the Region to update the L.U.R. (Regional Town Planning Law) to introduce the tripartite planning model (structural plan, operative plan, building and town planning regulation), and the Municipality of L'Aquila to draw up, as an interim measure and pending the new L.U.R., a *master plan* understood as a plan for the reconstruction of all the urban networks, thereby confirming its programming nature and omitting the true objective of foreshadowing a new structural plan. It states that «in the period necessary to draw up the new structural town plans according to the reformed model mentioned above, an interim period that might not be a short one, when there is no coincidence between programmatic indications in the *master plan* and prescriptions of the current town planning instruments, the necessary building permits will be issued thanks to a specific variant procedure»[35]. Constructing a city through projects presupposes having an institutional background of knowledge in which emerge the values and risks able to guide the processes of transformation, and in this case the map of the places and landscapes of the Region of Abruzzo can be a good starting point, but also assessing each single project in terms of coherence with the urban structure and with the landscape. Also in this case the urban history of last century tells us about the way in which the project has succeeded in contributing effectively to the growth of the city, thanks also to a singular process of personalization in favour of the proponent to whom local history still recognizes paternity. It should in fact be observed that these moments have been accompanied by *leaders* who have succeeded in achieving the programmed objectives thanks to a renewed policy of alliances in favourable circumstances due to the joint presence of social and economic factors ready and willing to accept the leap forward determined by the project. Only in the recent past, L'Aquila has experienced many of these:

PERIOD	LEADER		FUNCTION – THEME –
20th century	Name	Role	INSTITUTION INTRODUCED
'20	Adelchi Serena	Podestà, Minister of Public Works and National Secretary of National Fascist Party	Tourism & sport
'40	Nino Carloni	Local politician	Regional Musical Institution
'50	Vincenzo Rivera	University Professor and National politician	University of L'Aquila
'60	Lorenzo Natali	Parliamentary Minister, Deputy Commissioner CEE	Motorway A24 Rome-L'Aquila
'60	Luciano Fabiani	Regional Politician	Regional Theatrical Institution
'70	Lorenzo Natali	Parliamentary Minister, Deputy Commissioner CEE	State industry
'80	Antonino Zichichi	University Professor	National Institute of Nuclear Physics

Tab.2 Table of the main projects in the 20th century

It is interesting to note that for more than 30 years the city has not incremented its rare functions, demonstrating the end of a competitive political and planning cycle. What is more, the public inefficiency shown in the handling of the shocks in the 21th century and the lack of leaders capable of rising above present short-sightedness hold out little hope for the future of the city[36].

5 CONCLUSIONS

The role of the Plan in the management of conflicts and consensus of the participated post-shock reconstruction processes can be an indicator in assessing the effectiveness of public action. 5 years after the earthquake of 2009 a serious slowing down is revealed in resolving problems involving 73,000 persons and

[35] This indication is actually surpassed in 2014 by the decision of the Municipality of L'Aquila to draft a plan of tradition by starting the general variation of the current PRG. It is expected expansion of the city to accommodate a population increase of 10% from the current one. is in contrast with the general policies for the reduction of the land to be urbanized and in spite of the decrease of the residents (ISTAT 2011). Continue aggression to agricultural land in the rural area and the interstitial free territory. As it happened in 2009 for the construction of public housing after shock.

[36] Is absent participatory consensus building around the PRG. Reference is made to the institutional silence towards the new PRG Preliminary Document presented in 2012 by the Association Domani L'Aquila. This document has not yet discussed by the MC.

in the requalification of the urban spatial configuration. The management models for the emergency and reconstruction have oscillated between governance and government; the various forms of the plan between those of conformative, regulatory and predictive tradition and innovative tripartite and strategic ones; the themes qualifying the city oscillate between the *smart city* and the city in expansion with low densities. Thus what comes about is a difficult coexistence in the time of actions undertaken also because of a limited participation of the actors involved and of local society. The urban history of L'Aquila shows us instead the existence of a close link between urban transformations, the plan, participation and shocks. It is to be hoped therefore that the return to the participated season of the Plan may make the reconstruction of the city coherent with its urban history, in which the policy of alliances will accompany public action in a territorial space that is more vast than the administrative area, and in certain qualifying themes such as urban technological innovation and environmental sustainability.

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ASSESSMENT ON THE EXPANSION OF BASIC SANITATION INFRASTRUCTURE

IN THE METROPOLITAN AREA OF BELO HORIZONTE - 2000/2010

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ABSTRACT

The Metropolitan Area of Belo Horizonte is consisted of 34 municipalities, however approximately 79,68% of its population is concentrated at the conurbation zone with 19 municipalities. This zone presented different expansion axis (North, South, West) throughout the time. This article intends to assess the investments made in basic sanitation infrastructure (access to water supply, sewage collection network and garbage collection service) within the period from the years 2000 to 2010. For this purpose, land cover maps for these years were created to identify the new urban expansion axis. Maps of the census sectors of both years were also made with the percentage of households attended by the basic sanitation services infrastructure, as well as the population density and average income of the householder. Considering the results, we have observed that the investments in basic sanitation infrastructure in the last ten years were not sufficient, given the fact that the region with the largest population of Minas Gerais still has precarious conditions regarding the access to water supply and sewage networks. The least of the problems, but still a problem, is the garbage collection services, given the fact that to collect, the investment is low but it is important to highlight that the data do not bring information about the treatment and disposal of the garbage or sewage, they only inform us were those types of residue are collected.

KEYWORDS

Basic sanitation, Metropolitan Area of Belo Horizonte, GIS, Population, public investment

1. BRIEF HISTORY OF THE URBAN OCCUPATION OF BELO HORIZONTE – MINAS GERAIS - BRAZIL

Belo Horizonte was planned and designed at the end of the 19th century, after a political decision that made it the capital of Minas Gerais (MG). It was inaugurated in the year 1897, but only in the 1930s that the capital assumed the role of economic and cultural centre of MG, after having gone through an intense urban growth process, which expanded from the original plan made by Aarão Reis.

According to Tonucci Filho (2012), the 1940s was a decade characterized by structuring interventions that hurried the urban expansion and enabled the industrialization, like the implementation of the Industrial City (Cidade Industrial) and the Pampulha Complex. However, it was only in the 1950s and 1960s that the conurbation and metropolization processes of Belo Horizonte began.

In the 1970s an intense economic growth marked the decade, due to the “Brazillian economic miracle” that enabled various investments in different structural projects and services, which made the capital even more alluring. However, according to Tonucci Filho (2012), in Minas Gerais, a centralizing economic model was adopted that resulted in an economic, social and cultural segregation, amplifying the inequality of the access to leisure and services.

> *“The expansion of Belo Horizonte presents some characteristics of recent urbanization, materialized in spatially in fragmentation and dispersion of the urban fabric, associated to increasing social spatial segregation mechanisms”* (Costa e Peixoto 2007, translated freely by the author).

The following period (1980’s) was marked by economic recession that increased the unemployment and intensified the urban social problems. On the Metropolitan Area of Belo Horizonte (RMBH), this period was marked by the peripherization of irregular settlements and growing “favelization”. At the period between the 1990 and 2000, significant changes on the social structure of the RMBH happened. With a larger interest on the south axis due to the development of urbanization and gated communities justified by the safety and environmental quality speech (Costa 2003), and the North axis, with the government’s investments to increase the area’s value. In this sense, the study area here presented refers to the conurbation area of Belo Horizonte (Picture 1), that has an area of 1,716 Km² and a population of 4,314,967 inhabitants, that corresponds to 79.68% of RMBH’s total population (IBGE 2010).

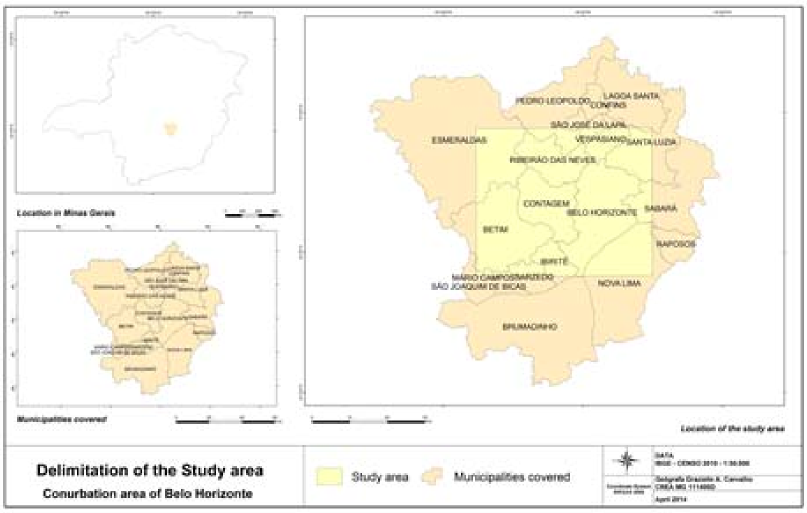


Fig. 1 Location of the study area

2 OBJECTIVES

Identify the priority investment areas of basic infrastructure in the conurbation area of the RMBH, MG, Brazil.

3 METHODS

3.1 TEMPORAL STATIC ANALYSIS OF LAND USE AND OCCUPATION

For the land use analysis of the study area, LANDSAT imagery, with a resolution of 30 meters, and a WGS84 – Zone 23, UTM coordinate system, was acquired from the University of Maryland website, where the data from the 2000 period is available, and from the United States Geological Survey (USGS) the scenes of 2013. The images selected are in geotiff format and orthorectified.

Using Arcgis 10, a 432RGB of selected bands for the year 2000 scene and 543 RGB composition for the 2013 scene were made, however all the compositions refer to the wavelength within the interval between 0,5 and 0,9 micrometres, corresponding to the visible spectrum (green and red) and near infra-red (NIR).

The LANDSAT scene involves a area larger than the study area, in this sense, it was extracted only the area of interest using a mask with the same dimensions of the study area.

From this point forward, began the supervised classification process with Arcgis 10. To do such classification was created a polygon shapefile with samples of land use; the samples were manually selected for the following classes: Water, bare soil, dense vegetation, underbrush, urban/altered.

The applied method was the Maximum Likelihood Classification, from which the software searches for pixels of similar spectral behavior from previously selected samples, classifying them accordingly (Picture 10). The accepted similarity threshold selected was of 0.9, on a scale from 0 (zero) to 1(one).

Once the land use classification process was finished, the raster format was converted to polygons, which allowed the calculation of the area of each type of land use for each year.

3.2 RECOGNITION OF THE STUDY AREA

The following analysis and maps presented refer to a comparative analysis of the region based on data from the 200 and 2010 Census of IBGE. The data are on a 1:50000 scale, in census sector format. The analysis addresses variables like basic sanitation infrastructure (water, sewage and garbage collection), income and demographic density.

We calculated also the relative population growth index for the period from 2000 to 2010, expressed by the following equation:

$$((Nf-Ni)/Ni)/time)$$

Equation 1: Relative population growth index

The data was grouped into five classes with the same interval to enable the comparison. The option to express the basic infrastructure data as a percentage was made because we believe that in this format the comparative analysis can be more accurate. It is noticeable that in the 2010 data some sectors do not have information, this is due to lack of data provided by the IBGE.

4. LAND COVER ANALYSIS – 2000 TO 2013

In the years before 2000, the study area was characterized by a dense urban spot, concentrated in Belo Horizonte, presenting a growth tendency to West (Contagem and Betim). It presented also bare soil distribution surrounding the urban area, showing new areas of interest for allotments intensifying the periphery and growth processes of Belo Horizonte tending to the North vector, which demonstrated also the high interest and investments of the real estate sector on the area.

In the year 2000, it is noticeable that the urban spot occupied practically the entire bare soil areal, remaining in this period around 42,55 Km² that corresponded to new areas of this typology (Picture 2). It is possible to observe also that the percentage of underbrush decreased, which demonstrates the pattern of occupation in the different typologies, where the urban occupies the bare soil at first and then the underbrush areas.

In Nova Lima it is easy to identify the urban spot growth in detriment to the underbrush. This phenomena refers to the one previously cited, characterized by the appreciation of the South axis and the peripherization process that led to some investments by the Government in the North axis, seen in Vespasiano, Ribeirão das Neves and Santa Luzia.

CLASS	AREA (2000)	AREA (2013)
Water	12.604	6.372
Bare soil	42.550	46.662
Urban	495.565	547.094
Underbrush	648.370	608.342
Dense Veg.	517.298	507.917
Total	1.716.389	1.716.389

Tab. 1 Comparison between areas (Km²) occupied by different land use types

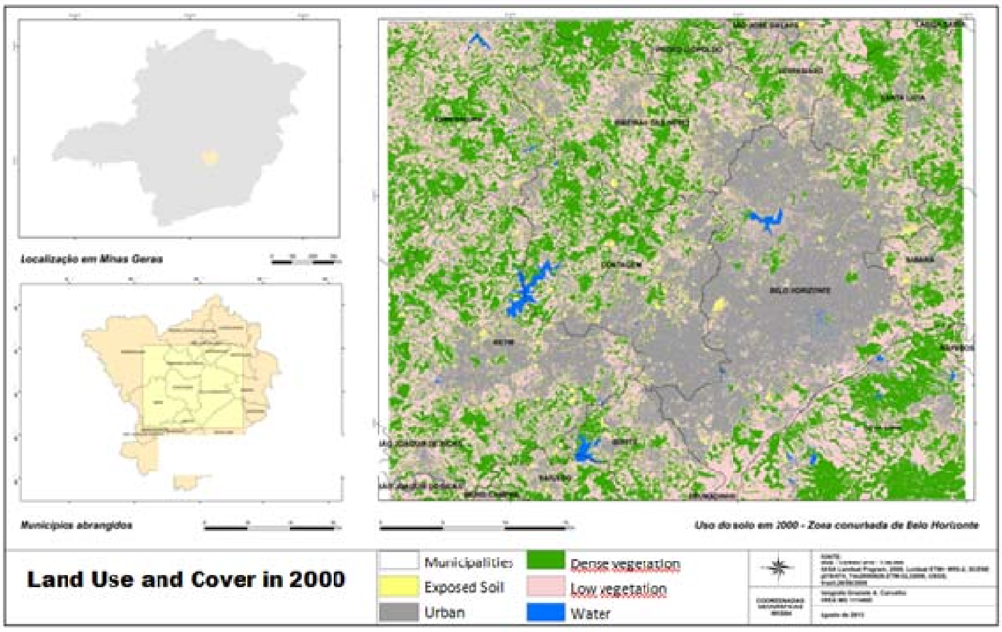


Fig. 2 Land Use and Cover in 2000 – Conurbation Area of Belo Horizonte

The analysis of the land use coverage of 2013 (Picture 3) shows clearly the build-up of sediment on the West branch of the Pampulha Lake and at Petrobrás Lake, between Ibirité and Sarzedo, completely filled by sediments in 2013, validating the data presented at Table 1, demonstrating the reduction of 6 km^2 in the area occupied by water. This is due to the sedimentation processes of other watercourses, or to the fact that some were covered by roads. Besides, we can observe that the urban spot grew around 50 km²; the underbrush lost 40 km², and dense vegetation, for the first time lost its remaining 10 km². Moreover, the bare soil growth of 6km² refers also to the area exposed by the loss of watercourses.

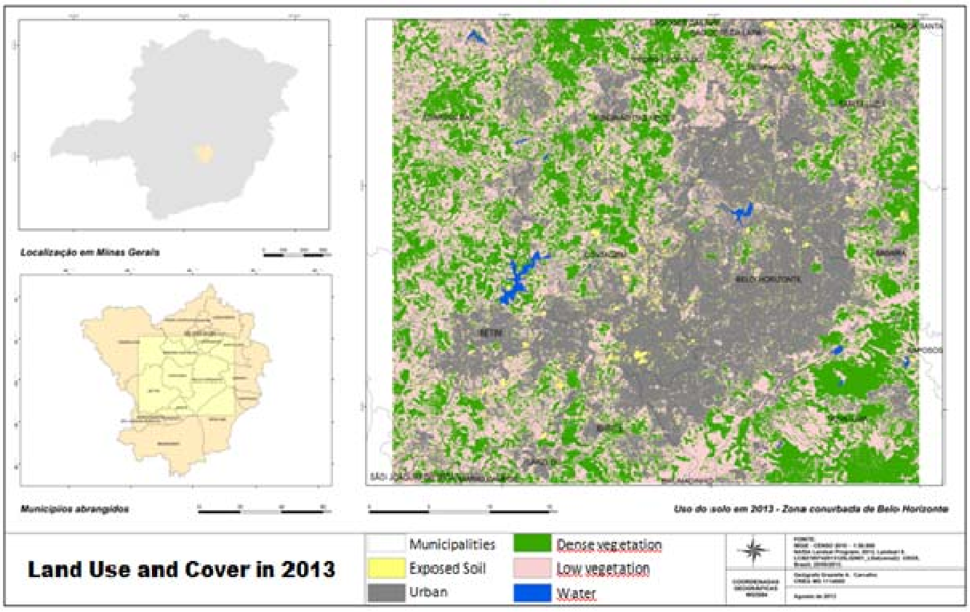


Fig. 3 Land Use and Cover in 2013 – Conurbation Area of Belo Horizonte

The map of land use and cover of 2013 also shows a larger concentration at the border between Nova Lima and Brumadinho, South Axis of Belo Horizonte, the proximity to the historical centre of Sabará (East of BH), and along the municipalities of the North axis: Vespasiano, Santa Luzia and Ribeirão das Naves. In Santa Luzia's case, it can be explained by the implantation of the Cidade Administrativa (Administrative Centre of the State), that led to an increase of interest on the region by the real estate sector, implementing numerous urban projects, including the Federal Government housing program "Minha Casa, Minha Vida".

5. POPULATION DENSITY AND INCOME

The analysis of the population density and income spatializes itself differently. We opted to analyse all the municipalities inserted completely or partially to avoid errors related to border effects that could occur when considering only part of a sector that was within the involving rectangle, but when selected, could bring the data of the entire sector.

Therefore, the study here relates to 19 municipalities, all of which touched by the involving rectangle that outlines the study area, with a total population of 4.615.888 inhabitants[1].

It was observed that the population growth in the years from 2000 to 2010 was generally low. Overall the average of residents per household (Picture 4) decreased in the last decade, even in municipalities previously considered as peripheric, that is the case of Lagoa Santa (East portion, from 4 - 6 to 2 - 3), Santa Luzia (South East portion, from 4 - 6 to 3 – 4) and Ribeirão das Neves (from 4 – 6 to 3 – 4).

1 Bearing in mind that the population of the study area is 4.314.967 inhabitants, which leads to an increase of 300.921 inhabitants when considering the analysis of the municipalities and not only the census sectors that touch the involving rectangle. It is equivalent to an increase of 6,51% of the analysed population.

In Nova Lima, at its West portion, the residents' average has increased, that verified also on the east portion of Brumadinho, on its border with Nova Lima, as a reflex of the valorisation of Belo Horizonte's South axis.

In Belo Horizonte, it is observed that the last decade cemented the movement of expulsion of residents from the central areas, and its peripherized area decreased the average from 4 – 6 to 2 – 3 residents.

In general, the average of residents for the neighbouring municipalities of Belo Horizonte, previously considered periphery, decreased. Fact that makes us assume that the periphery is further from the capital, that the population has been led to live further away from the cultural, economic and service centre of Minas Gerais, due to the valuing of land property in this area.

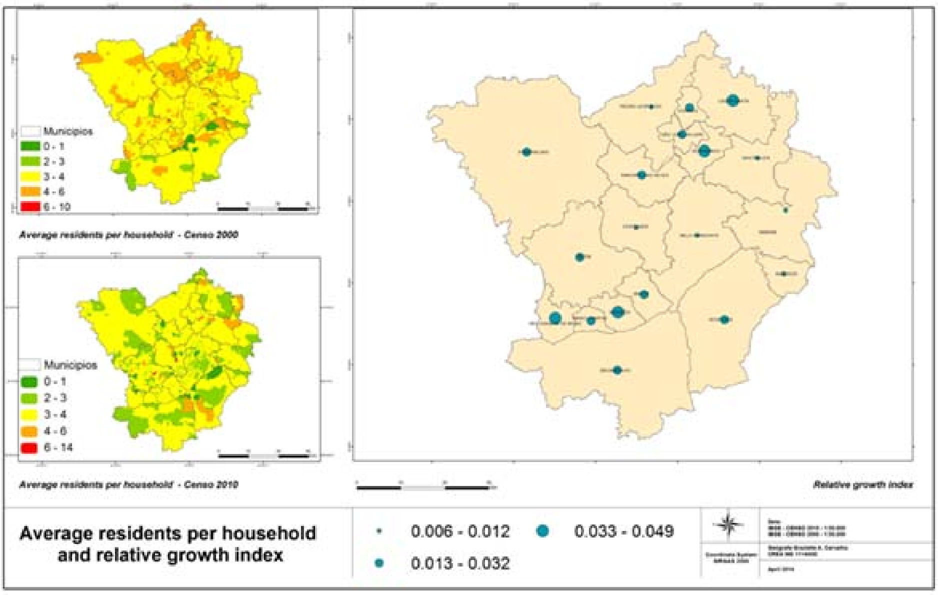


Fig. 4 Average residents per household and relative growth index

Regarding the monthly average income of householders per residence (Picture 5) it is noticeable a larger income distribution, yet not the ideal.

Except in Belo Horizonte, in the year 2000 it is observed that the predominant income of householders was under R$800.00 (eight hundred reais) in all the municipalities. In the year 2010, we can still notice a significant occurrence of this class, but can also notice a larger distribution of the class corresponding to the income between R$800.00 and R$2000.00 (eight hundred to two Thousand reais).

On the other hand, the larger incomes occur in Belo Horizonte, as expected, but is important to also highlight Nova Lima, with incomes varying between R$6000.00 (six Thousand reais) to R$51000.00 (fifty one Thousand reais). These values also occur in Belo Horizonte, especially concentrated around the Pampulha Lake and South-Central region, which have the capital's most economically valued neighbourhoods.

In broad sense, we can verify that the regions with the lowest income are the ones that present the largest average of residents, and the ones with higher incomes, the lowest number of residents. This could be explained by the fact that living in those areas has become more expensive, with a heated real estate market, rental prices are expensive and apartments appraised overprice for sale. Therefore, to live alone in areas nearer the capital's centre is necessary to have a good monthly income, as well as in Nova Lima.

We have noticed here a very superficial income distribution, especially if compared that in the year 2000 the highest average income was of R$10196.00, and in the year 2012 it is above R$51000.00. However, the areas where those values occur are the same in both years, meaning that the richest people in Belo Horizonte became even richer, about 400%, while the less favoured class, in the best scenario had an increase of 150%, where others have not had any change.

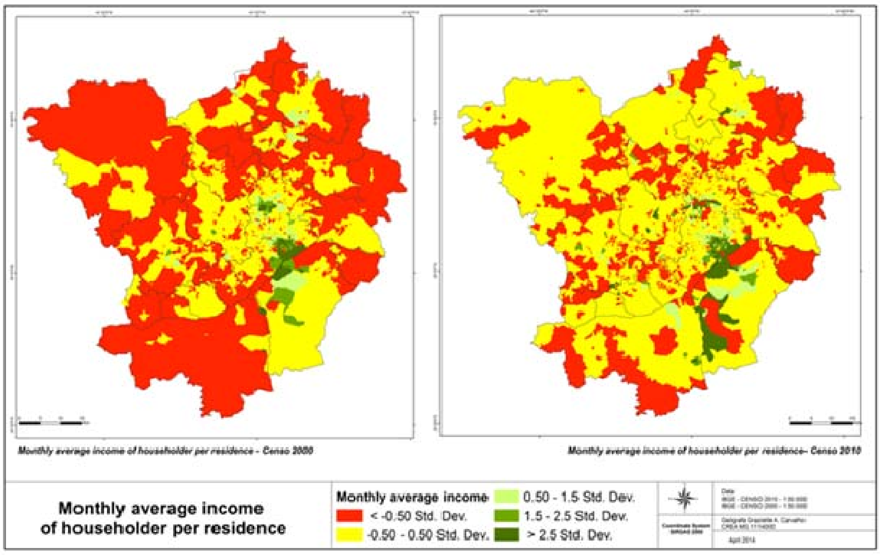
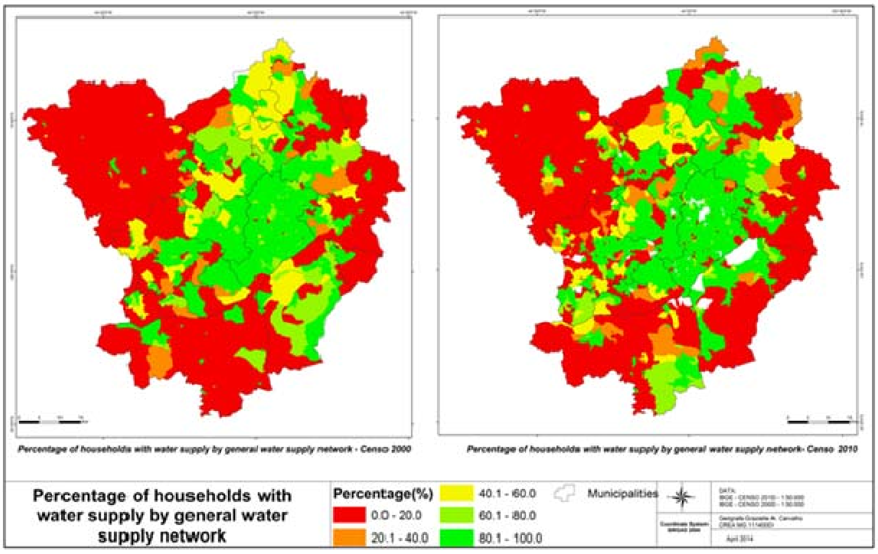


Fig. 5 Monthly average income of householder per residence

6. BASIC INFRASTRUCTURE: ACCESS TO WATER, SEWAGE AND GARBAGE COLLECTION

When analysing the percentage of households with water supply by general network (Picture 6) we observed that Belo Horizonte, except in some villages and favelas, is completely covered by the water supply service. However, the same situation does not occur on the neighbour municipalities.



Picture 6: Percentage of households with water supply by general water supply network

On this map, we can observe three scenarios: improvement on service provision, worsening on service provision or no change.

The unaltered spot can be understood as: there was no increase on the demand for the service and because of that, no investments; or there was a demand for the service but the investments made where enough to maintain the percentage of the attended population the same as in the year 2000.

Improvements are noticed in the municipalities of São Joaquim de Bicas, Southeast portion of Brumadinho, west and north portions of Nova Lima, central portion of Lagoa Santa, the entire municipality of Confins, the central portion of Esmeraldas, border with the West portion of Ribeirão das Neves, in which improved also the percentage of attended population. These areas correspond to those where investments were made to increase the access of population to the general water supply network.

Worsening are noticed in the Southeast portion of Nova Lima, where its population contingency increased in the last decade, but the service did not accompany this growth, as well as the east portion of Sarzedo and South of Pedro Leopoldo, centre of Contagem and south portion of Betim. The ones that maintained the same percentages of attended population in the year 2000 were Sabará, Raposos, São José da Lapa, Esmeraldas (except its centre) and Vespasiano.

The municipalities that have most of their population without access to water supply network, that is the case of Esmeraldas, this service is provided through welds or spring water (Picture 7). This scenario is verified also at the south of Nova Lima and central area of Brumadinho, due to these areas having a resident average close to 1 or 2. In this sense, Esmeraldas' situation is more serious, as well as the South portion of Sarzedo, since the average residents in those places are of 3 - 4.

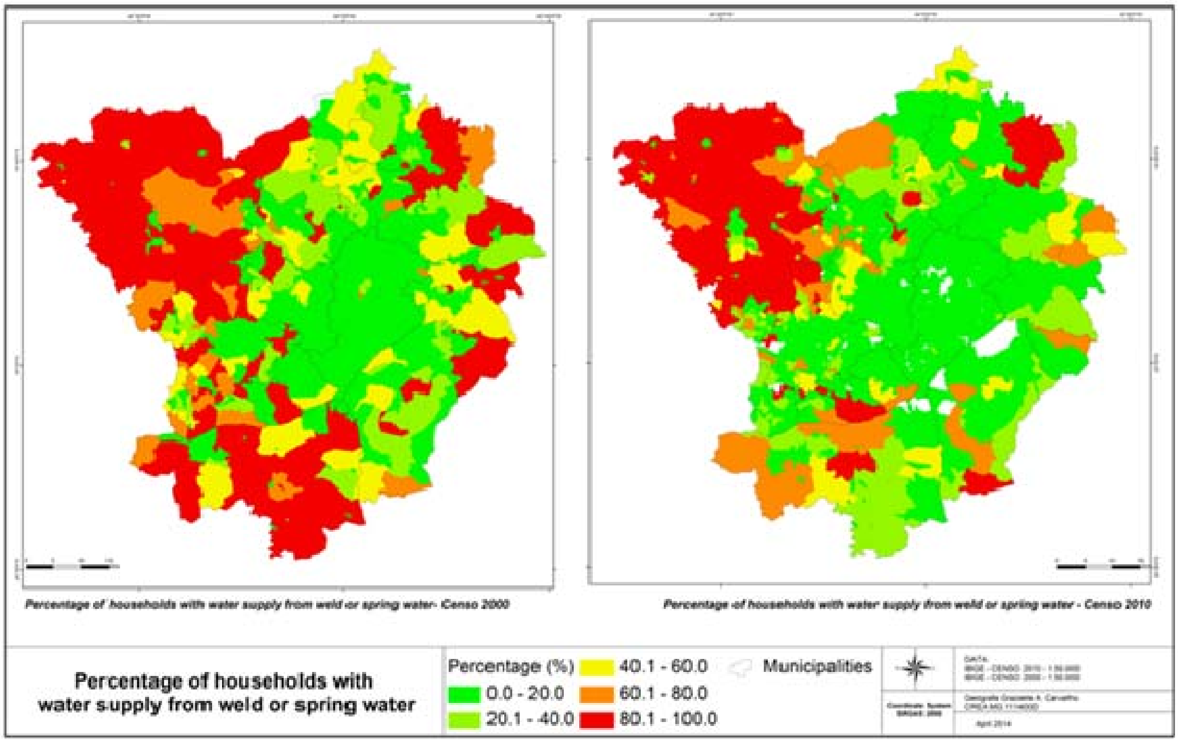


Fig. 7 Percentage of households with water supply from weld or spring water

When analysing the scenario presented by the percentage of households with bathroom and sewage collection by general sewage or pluvial network collection, we are assessing the percentage of households that have sewage collection and not necessarily if this residue is treated or not. Since the data provided does not discriminate which ones go to the general sewage collection network or to the pluvial collection network. Anyway, it is a chaotic scenario. Different from the water supply, the sewage collection is restricted to Belo Horizonte. What we observe both in year the 2000 and 2010 is a big red stain, informing us that about 80 – 100% of the population in those areas does not have access to this service (Picture 8). Being that, the scenario for the other municipalities are of sewage collection by improvised tanks (Picture 9) and sewage collection by septic tanks (Picture 10).

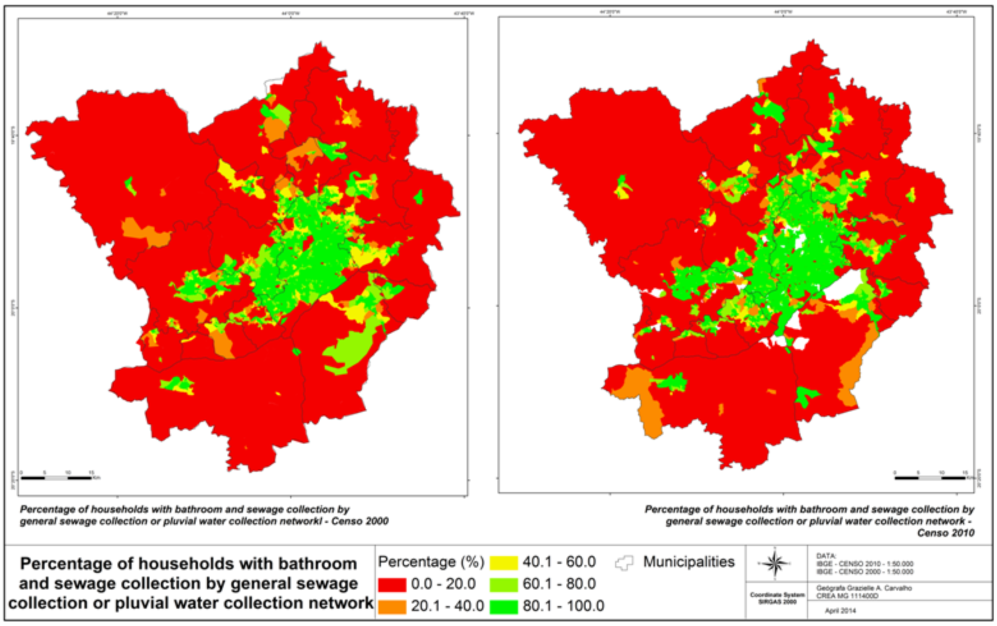


Fig. 8 Percentage of households with bathroom and sewage collection by general sewage collection or pluvial water collection network

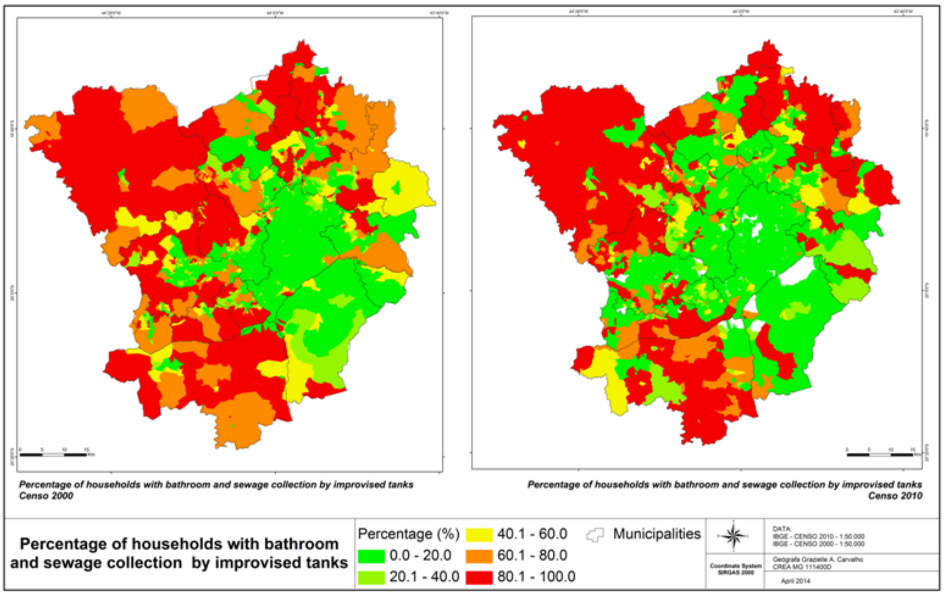


Fig. 9 Percentage of households with bathroom and sewage collection by improvised tanks

For the improvised tank, we have noticed a significant increase on the Nova Lima region that also presents the largest resident average (4 - 6); access to water is predominantly by weld or spring water and have the lowest income. We can highlight the area as one that needs more attention from the Nova Lima government.

Sabará presented an improvement on the percentage of the population depending on improvised tanks on its South portion (less populated) and worsening on the north portion (more populated, Ravena district). This worsening is also verified in Betim (South portion), Raposos and Santa Luzia (north portion).

Contagem (at its North portion), Ribeirão das Neves, São José da Lapa, Vespasiano and Lagoa Santa's centre presented a decrease on the percentage of population depending on improvised tanks. This happened because of more investments on septic tanks, which improves the environmental condition but not recommended as best alternative for treating sewage residue.

It is noticeable that the areas that presented a decrease on the sewage collection by improvised tank are the ones that now appear as septic tank: Contagem, Ribeirão das Neves, São José da Lapa, Vespasiano e o centro de Lagoa Santa. This also occurred in Nova Lima, which on its case refers to the real estate developments that moved to the municipality supported by an environmental speech and for such, would be contradicting to install improvised tanks, which are highly polluting.

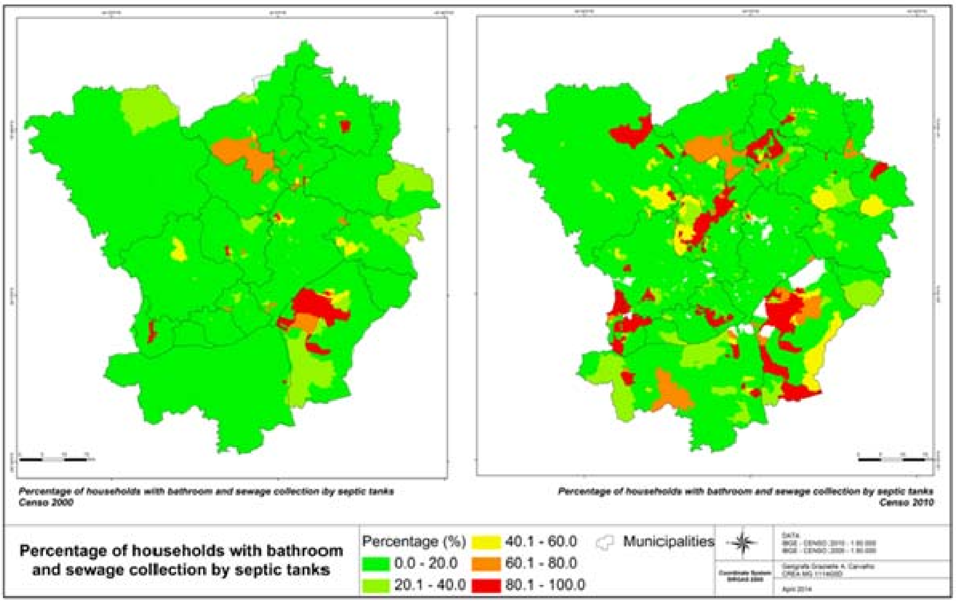


Fig. 10 Percentage of households with bathroom and sewage collection by septic tanks

Regarding the urban cleaning services (Picture 11), we can observe a much more positive scenario, with substantial improvements in the North axis municipalities (Vespasiano, São José da Lapa, Confins, Ribeirão das Neves, Lagoa Santa – West portion, e Santa Luzia – Southeast portion) as well as in the South axis municipalities (Nova Lima, Brumadinho, Sarzedo e Mario Campos).

Santa Luzia and Sabará located east from Belo Horizonte, presented improvements regarding the service provision in garbage collection as well, although they present large areas still unattended. On the West side of Belo Horizonte, the worst scenario is in Esmeraldas, although its centre presented improvements on the service as well as the northeast portion of the municipality.

It is seen that the garbage collection by container (Picture 12) is not very used, which leaves very unsustainable options to try and understand what is done to the garbage that is not collected by public service or container, leaving the following options of throwing in abandoned lots, burned, buried or dumped in the rivers. Anyway, if the garbage is not collected it does not receive the proper treatment needed to avoid environmental problems such as soil, water and other types of contamination.

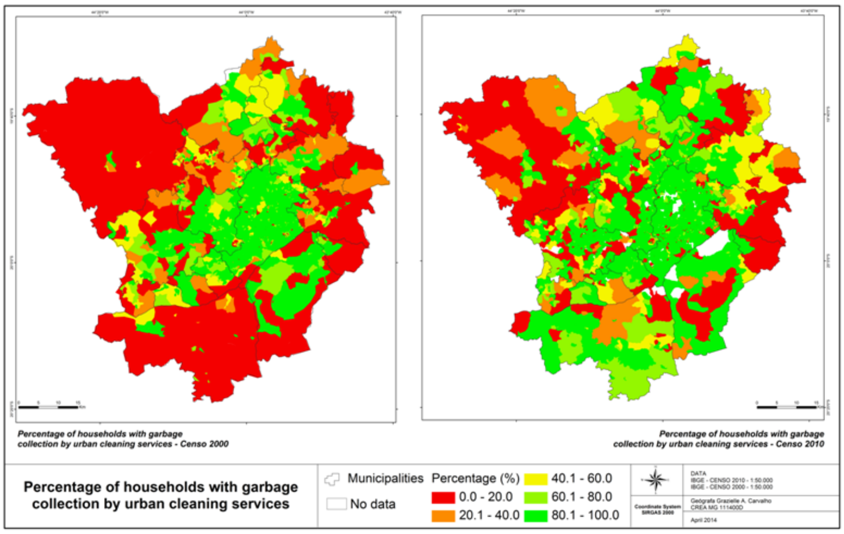


Fig. 11 Percentage of households with garbage collection by urban cleaning services

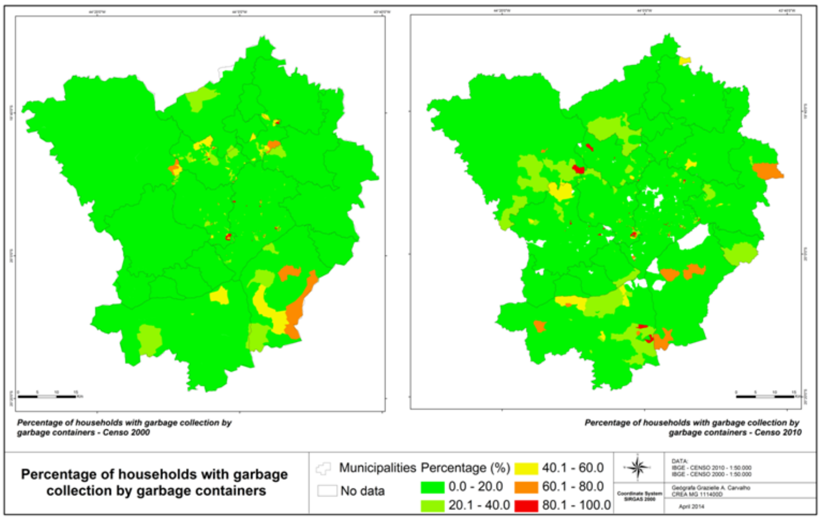


Fig. 12 Percentage of households with garbage collection by garbage containers

7 FINAL CONSIDERATIONS

Facing the presented scenarios, we have observed that the investments made in basic sanitation infrastructure in the last 10 years were insufficient. The area with the largest population contingency of Minas Gerais is still in precarious conditions regarding the access to water supply network and even more sewage network.

There is a high correlation between income and investments made on infrastructure, where places that present population with a higher income average are the ones with the higher percentage of households with installed infrastructure. It is noticeable that the population with lower income, located on the periphery or at the new growth axis of the urban fabric, still present the lowest indexes of access to basic sanitation services.

It is noteworthy that Belo Horizonte is characterized as a monopolizing centre of investments on sanitation infrastructure, which can be explained because of the larger population contingency and being one of the richest municipalities in Minas Gerais. However, its neighbours do not count on the same amount of investments. Although Belo Horizonte is responsible for about 45% of the RMBH's population, the remaining residents are living in precarious conditions of basic sanitation or not having access to the services. We can observe the segregation pattern of the capital reflecting on the RMBH.

Another limitation we had on the analysis of the data was the way they were presented, once we have the information about the garbage and sewage collection, but not the information regarding the final destination of those residues, if they are treated or not.

If at the RMBH we have scenarios of a large population percentage that does not even have access to the service of garbage collection and sewage, we can imply that regarding the disposal of these residues the situation is even worse.

This article comes to demonstrate that even with a simple method of map overlaying is possible to identify priority areas for investments. These areas, in the RMBH's case, are located along the middle and lower class population and it makes necessary ensuring the rights regulated by the Brazillian Civil Constitution of 1988, which guarantees access to the services of basic sanitation infrastructure, but is being neglected by the Government's administrations of those municipalities.

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Contribution to the Project "Parametric Modeling of Territorial Occupation: proposal of new resources of geo-technologies to represent and plan the urban territory", with the support of CNPq – National Council for the Scientific and Technological Development - Call MCTI/CNPq/MEC/CAPES Nº 43/2013, Process: 405664/2013-3 Scholarship CAPES/Brazil.

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IMAGES SOURCES

All images are from the author.

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TEMPORARY DWELLING OF SOCIAL HOUSING IN TURIN

NEW RESPONSES TO HOUSING DISCOMFORT

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ABSTRACT

In Turin the Compagnia di San Paolo had fostered two social housing initiatives, committed in handling the complex and fragmented housing discomfort issue. In the face of the social, economic and cultural development that has radically changed the housing emergency distinctive features, the new housing policies, realised with interventions of Edilizia Residenziale Sociale (ERS), represent one possible response to the growing housing needs of a wide segment of population.
The two temporary dwelling of social housing are born under a common denominator: the challenge has required the ability to find the balance between solidarity, social inclusion, housing rights and the real estate market. In the meantime they represent city laboratories where testing good practices and innovative usual procedures and engine of new experiences and future experimentations.

KEYWORDS
Social housing, temporary dwelling, social inclusion, housing discomfort, urban regeneration

1 INTRODUCTION

In the last decade, a new term has entered the common language of housing policies, that of social housing. According to the definition given by Cecodhas Housing Europe (The Federation of public, cooperative and social housing), social housing is “housing for those whose needs are not met by the open market and where there are rules for allocating housing to benefiting households” (Cecodhas 2006).

The concept of social housing in the European Union is characterised by the wide diversity of national housing situations, conceptions and policies in relation to the specific characteristics of the context; however, it is possible to identify convergence of objectives common to all member countries of the European Union (EU), namely: the existence of specific missions of general interest; increase supply of affordable housing through the construction, management, purchase, and letting of social housing; and the definition of target groups (either in socio-economic terms or in relation to other types of vulnerability) (Cecodhas 2007).

Already in 2000 the right to social and housing is included in the Charter of fundamental rights of the European Union[1]: “in order to combat social exclusion and poverty, the Union recognises and respects the right to social and housing assistance so as to ensure a decent existence for all those who lack sufficient resources, in accordance with the rules laid down by Community law and national laws and practices”[2]. The goals concern the increase in low-cost housing supply, in order to facilitate the access to real estate market the poorest segment of the population, ensuring the quality of interventions.

The most recent European measure goes back to 2010, and was presented with the report Europe 2020 (Agenda 2020) that defines the growth strategy for the next decade. Between the 5 targets for Europe 2020, fighting poverty by lifting at least 20 million fewer people in or at risk poverty and social exclusion, is one of the main issues.

In the matter of social inclusion, as stated by the European Commission homelessness and housing deprivation are perhaps the most extreme examples of poverty and social exclusion today. The importance of having access to affordable accommodations has been highlighted as one of the core factor to prevent and combat social exclusion in Europe (Cecodhas 2011).

In Italy the definition of social housing refers to *alloggio sociale* in the Ministerial Decree of 22 April 2008 that defines it as “the housing unit used for residential use in permanent lease that performs the function of general interest, to reduce the housing problems of socially vulnerable people who are not able to access the location of housing in the free market safeguarding social cohesion. The *alloggio sociale* is configured as an essential element of the system of social housing, consisting of housing services aimed at meeting the basic needs”[3].

[1] The European Parliament proclaims the Charter of fundamental rights of the European Union in Nice on December the 7th 2000.

[2] Charter of fundamental rights of the European Union, article 34, paragraph 3 (Social security and social assistance)

[3] English author translation of “l'unità immobiliare adibita ad uso residenziale in locazione permanente che svolge la funzione di interesse generale, nella salvaguardia della coesione sociale, di ridurre il disagio abitativo di individui e nuclei familiari svantaggiati, che non sono in grado di accedere alla locazione di alloggi nel libero mercato. L'alloggio sociale si configura come elemento essenziale del sistema di edilizia residenziale sociale costituito dall'insieme dei servizi abitativi finalizzati al soddisfacimento delle esigenze primarie” - Ministerial Decree of April 22 2008 “Definizione di alloggio sociale ai fini dell'esenzione dall'obbligo di notifica degli aiuti di Stato”, ai sensi degli articoli 87 e 88 del Trattato istitutivo della Comunità europea” art. 1, c. 2.

In such a context the experience carried out by the Programma Housing[4] della Compagnia di San Paolo, in close collaboration with the Ufficio Pio[5] since 2009, and in partnership with other external parties has promoted two experimental projects aimed at building two Temporary Dwellings in Turin.
The Temporary Dwelling can be defined as "structures intended for subjects in a situation of housing vulnerability or that need transitory housing solutions; they are distinguished by the temporariness of the guests' stay, by limited rent costs and by the opportunity, for people living there, of enjoying common services and spaces. The social purpose of these actions is to provide a response to the housing discomfort" (Ingaramo 2012).
These buildings may represent one possible response to the growing housing needs expressed by a segment of the population that is placed in the so-called "grey zone" of income, that is a range that does not allow access to programs of public housing, but at the same time it is not sufficient to cover the costs of the rent that characterise the market rent.

2 THE SOCIAL HOUSING AND THE RIGHT TO HOUSING

Taking into consideration the numerous interventions aimed at providing possible responses to the growing housing needs, the term social housing, loan word that has now become part of the common lexicon, takes on the general characteristics of Edilizia Residenziale Sociale (ERS) (Social Residential Housing).
Given that the social, economic and cultural development that has radically changed the housing emergency distinctive features, the new housing policies, realised with interventions of Edilizia Residenziale Sociale (ERS), represent one possible response to the growing housing needs of a wide segment of population.
The ERS policies are not addressed to all citizens. The social dwellings are designed to meet the demand for housing services to the benefit of users that have very specific characteristics, above all the economic condition.
It is possible to identify two broad areas of housing problems. The first area consists of those who live in a situation of absolute housing emergency, and do not have the opportunity to live in a dignified and secure place. In this area of social disadvantage, the housing problem is configured as the need to ensure immediate reception, even in an emergency situation, to ensure an even temporary accommodation to socially vulnerable individuals and families. On the other hand, the problem is to ensure over time the housing rights for those who are actually in critical economic conditions and are not in a position to pay a rent, if not extremely modest. This social demand is mainly satisfied by the housing offer made possible through the implementation of public housing policies (ERP).
Another area includes, instead, people who are not in a state of absolute uncertainty, and often have an income, but cannot afford the cost of housing in the free market. For people of this area, the housing issue is a inhibiting factor (in young people self-sufficiency, in moving for study and work, in family projects) and a major risk factor facing with unforeseen events (eviction, separation, or the end of a cohabitation).
The changing conditions in the real estate market and the recession since 2008 in general, that have caused a significant extension of the gap between the average income of the population and the economic requirements to housing, have expanded the range of beneficiaries who can benefit from social housing; besides the areas traditionally considered most in need, the new categories of people include young people, single parents, students, temporary workers, the elderly and so on. They represent the social segment that

[4] The Programma Housing of Compagnia di San Paolo was born in novembre 2006 with the main objective to support social housing experience that can represent city laboratories where testing good practices and innovative usual procedures and contribute to the development of a new culture of social housing.

[5] Founded in Torino in 1595, the Ufficio Pio represents a reference point for the whole metropolitan area of Torino in aiding citizens with disadvantages.

is unable to have access to the free market for various reasons and at the same time do not have the economic and social conditions to access to public housing (ERP)[6].

The *alloggio sociale* definition includes “housing built by public and private operators, through contributions or public subsidies - such as tax exemptions, allocation of areas or buildings, guarantee funds, city planning facilitations (…)”[7].

The Ministerial Decree points out the both public and private presence in the realization of a social housing intervention; the article n.1, paragraph 4 says that “the service is provided by public and private operators primarily through the provision of rental housing (...)”[8].

Satisfying the housing needs of socially vulnerable groups can only occur if the services are offered in better terms than those of the free market which in inaccessible to them. The current emergency is to rebalance the relationship between the cost for having access to the housing market and the actual buying power means of the families.

The subjects involved in the implementation of social housing initiatives are both public and private. In fact, considering that the aim of social housing policies is to facilitate the access to housing services to those individuals who are unable to do it under normal market conditions, it is inevitable that this function is fulfilled through a public contribution. Public funding can take different forms, can be of varying size and proportions on the total investment, but such an investment would not be feasible without it. In fact, public funding allows to lower the construction costs of social housing interventions. Public funding can be granted in different ways:

- financial aid in the form of contribution on loan interest or contributions to invested capital;
- make available through sale or concession of surface rights, of building lot or buildings at price lower than market conditions;
- reduction, by the municipality, on planning fees and construction costs.

The private operator is represented by housing cooperatives, construction companies and also banking foundations.

3 TWO PROJECTS OF SOCIAL HOUSING BY THE COMPAGNIA DI SAN PAOLO

Social housing is a complex and fragmented sector that combines social aspects, financial and economic equilibrium, environmental issues, quality of life, etc...; a multi-disciplinary issue that requires an overall view of all its components: design, technical knowledge, environmental considerations, and social and economic aspects.

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6 The Article 11 “Piano Casa” of Decree Law n. 112/2008, (L. n. 133/2008), identifies the socially vulnerable groups:
- households with low income, including single-parent or single-income;
- young couples with low incomes;
- elderly people in disadvantaged social or economic conditions;
- non-resident students;
- immigrants with low-income residents for at least ten years in the country (...).

7 English author translation of “Alloggi realizzati o recuperati da operatori pubblici e privati, con il ricorso a contributi o agevolazioni pubbliche - quali esenzioni fiscali, assegnazione di aree od immobili, fondi di garanzia, agevolazioni di tipo urbanistico - destinati alla locazione temporanea per almeno otto anni ed anche alla proprietà” - Ministerial Decree of 22 April 2008, art. 1, c. 3.

8 English autor translation of “Il servizio viene erogato da operatori pubblici e privati prioritariamente tramite l'offerta di alloggi in locazione alla quale va destinata la prevalenza delle risorse disponibili, nonché il sostegno all'accesso alla proprietà della casa, perseguendo l'integrazione di diverse fasce sociali e concorrendo al miglioramento delle condizioni di vita dei destinatari” - Ministerial Decree of 22 April 2008, art. 1, c. 4.

The two temporary dwelling challenge is not simply due to the realisation of a number of accommodations but requires the ability to find the balance between solidarity, social inclusion, housing rights - the primary aims of social housing - and the real estate market. The main objective is to define new integrated actions from an architectural, social and cultural point of view. In this perspective, this initiative aims to regenerate the quality of life of the urban area starting from the two temporary dwellings.

The two buildings are located in thriving neighborhoods of Turin, immediately adjacent of the historic center, the first in Piazza della Repubblica, which hosts one of the largest outdoor markets in Europe, the second in San Salvario district, a multiethnic area where there is also a synagogue.

The choice of realizing the temporary residences in the areas of Porta Palazzo and San Salvario isn't fortuitous: these are quarters characterized by problems of urban deterioration and social tensions. The quarter of Porta Palazzo is an area with a high rate of immigration coming from southern Italy and, more recently, from abroad, where the coexistence between the different populations isn't peaceful but often is a source of social tension. In the meantime, this social situation helped to create a multicultural, creative and rich background in terms of stories, traditions and attractive spaces. The quarter of San Salvario has had more success than what happened at Porta Palazzo, although there are still problems of urban blight and social tensions causing discomfort and situations of conflict in some defined areas. Many private investors have seen in the multi-ethnic features a strength point for promoting initiatives of urban valorisation to foster social cohesion.

In these social and cultural contexts, the temporary residences aim to become a new polarity for the two quarters and another territory knot able to interact with the network of people living in them, continuing and strengthening the involvement of the Compagnia di San Paolo and of the Ufficio Pio in the activities that the city institutions and the social actors promote in these areas.

Both temporary residences are addressed to the following categories of receivers: population under housing stress, personnel in training and out of office workers, city users and occasional visitors and people in housing emergency. In particular, the structure of Porta Palazzo offers accommodation mainly to single people and couples without sons and the structure of San Salvario mainly for families with one or two parents and with minor sons.

3.1 PRIVATE INVESTMENT AND PUBLIC FUNDING FOR THE TWO TEMPORARY RESIDENCES

The Compagnia di San Paolo, a banking foundation, had fostered two experimental actions of public interest, actively contributing to social housing initiatives not for profit but because they are a unique and innovative experience of urban regeneration and social quality.

The *Documento Programmatico* of the Programma Housing states that the Compagnia di San Paolo focuses the attention more strongly on interventions on social housing issues with respect to some trends, such as:

- reduction of public funding on housing policies;
- transfer to the real estate market what social policies are no longer able to provide;
- new housing needs generated by immigration, job flexibility and changes in family structures.

The two residences fall within the "Social Housing Municipal Program". The acceptance of the principle that they are of general interest allowed, in the authorization phase of the projects, the exemption of the payment of planning fees and construction costs: in this sense, the inclusion in the program, is to be considered almost like public funding.

The building in piazza della Repubblica is owned by the City of Turin that in November 2008 published a call for assigning free loan for use the building in order to design it for temporary residence. The Ufficio Pio has entered the public tender, winning the god for 30 years: the standard fixed the realization of a “social hotel”

for single people and couples without sons, whom providing a temporary housing solution, at moderate rent, beside the possibility of enjoying common spaces.
The building in via San Pio V, instead, is owned by the Istituto di Santa Maria (Ex IPAB). In October 2008 The Ufficio Pio and the Istituto di Santa Maria signed an agreement, establishing the renovation of the entire complex and the partition in three parts:

- an infant school (2 classes)
- housing for the nuns and a chapel
- a temporary residence of social housing, common spaces and commercial areas.

Once completed, the Ufficio Pio will get free loan for use the temporary residence for 25 years.

3.2 RE-USE OF THE TWO EXISTING BUILDINGS

The Manifesto of Social Housing, presented at the end of the Urbanpromo 2011 edition and discuss further at the following year edition, states in the first paragraph - Urban Planning-, the need to "ensure the development of social housing pursuing environmental sustainability and territory conservation, giving priority to urban regeneration and reuse of historical buildings (...)".
The two social housing building assert this principle. The temporary residences have been realised in historic buildings. Both of them were in a severe degradation state so they have been extensively refurbished.
The main building, overlooking piazza della Repubblica, was built approximately in the first quarter of the XIX century[9]. The project area consists of: a historical building of 4 floors overlooking piazza della Repubblica, and a basement; a building of 3 floors, of little aesthetic and functional value, on the side facing via Priocca, realised in a later time and placed perpendicular to the main building; an open outdoor courtyard on Via Priocca.
The building in via San Pio V was built in the mid-XIX century. The courtyard building consists of: a main original building of 4 floors, in rearward position from via San Pio V; on the eastern side a block of 4 floors houses a chapel; two buildings of 3 floors close the internal side of the courtyard. The allotment is completed by two recent buildings of 5 floors overlooking the courtyard in front of via San Pio V.
Both the projects are respectful of the original connotation of the buildings and are characterized by a contemporary architectural language and innovative elements such as wooden sunbreak panels for shielding balconies and a continuous glass wall next to the restaurant in the Porta Palazzo project, and bow-window overlooking the street and the courtyard in San Salvario project.
The two temporary residences combine different functions: residence, services and commerce[10]. Both residences offer different types of apartments, equipped and furnished like a comfortable home, however temporary. Moreover, the temporary dwellings have some polyvalent spaces that host social and cultural activities opened to the neighbourhood. On the ground floor the residences have some commercial spaces.

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[9] In the last two decades it has been property of the University of Turin, then of the State and at the end of the City of Turin, in the 90's it has been illegally occupied.

[10] In the Porta Palazzo project the available surface area is approximately 2,250 sqm of slp. The projet has allowed the realisation of 27 flats (13 one room flats and 14 two rooms flats), 3 commercial units on Piazza della Repubblica, a restaurant (140 sqm) and a polyvalent space (200 sqm) for carrying out cultural activities related to the territory, apart from a laundry / ironing and other common services. On the available surface of about 3,363 sqm of slp, the San Salvario project allowed the realisation of 24 flats (6 one room flats, 10 two room flats , 6 three room flats and 2 four rooms flats), some common areas such as a kitchen, a laundry and a polyvalent space and some public spaces (another polyvalent space and 2 commercial spaces) for carrying out activities related to the territory. The building also houses an infant school and housing for the nuns.

The rent of these spaces will contribute to the economic sustainability of the structures. The commercial and social activities are addressed, not only to the guests of the temporary residences but to all citizens.

As previously mentioned in the Manifesto, the social housing interventions must follow the principles of sustainability, in particular the environmental sustainability, already expressed in the Ministerial Decree of April 22 2008 which states that "the *alloggio sociale* must be realised according to the principles of environmental sustainability and energy conservation, using, where possible, alternative energy sources"[11].

As to the environmental sustainability, the project for the Porta Palazzo temporary residence allows the production of energy for domestic hot water using solar panels placed on the roof and a photovoltaic systems placed on the roof and on the building facades. The materials used have certifications attesting the lowest consumption of resources and the highest efficiency of disposal: natural insulation as mineralized wood wool, pressed wood fiber, flakes of cellulose and recycled cork; natural or recycled materials as bamboo, Eco gres – certified Ecolabel, and Woodn (a material made of polyethylene and recycled wood).

Fig. 1 The building in piazza della Repubblica – Porta Palazzo: before and after

Similarly, the design project of San Salvario temporary residence involves the production of energy from renewable sources, through photovoltaic systems and solar panels to produce domestic hot water. As in the other project the paving material is the Eco gres and all paints are made with totally natural materials. Moreover, the rainwater is piped for irrigation of the vegetation in the two courtyards.

The incentive to submit eco-friendly planning proposals, that have to be developed in the perspective of an efficient economic management, seems to have met, together with a convincing composition and technological proposal, the requested goals of limiting energy consumptions and management costs.

Fig. 2 The building in via San Pio V – San Salvario: before and after

[11] English author translation of "l'alloggio sociale deve essere costruito secondo principi di sostenibilità ambientale e di risparmio energetico, utilizzando, ove possibile, fonti energetiche alternative" - Ministerial Decree of April 22 2008, art. 7.

3.3 THE IMPLEMENTION PROCEDURES

The entire development process of the two temporary dwelling has been planned on the basis of calls for public tender. The intervention of piazza della Repubblica started in 2009 and became operative starting from September 2013; that of via San Pio V began in late 2009 and the completion of the works is scheduled for the end of 2014.

Here below (fig. 3) are the main steps through which the implementation process of the two social housing temporary residence has been developed: from the buyout of properties, to obtaining building permissions, and identifying the subjects for the managing stage.

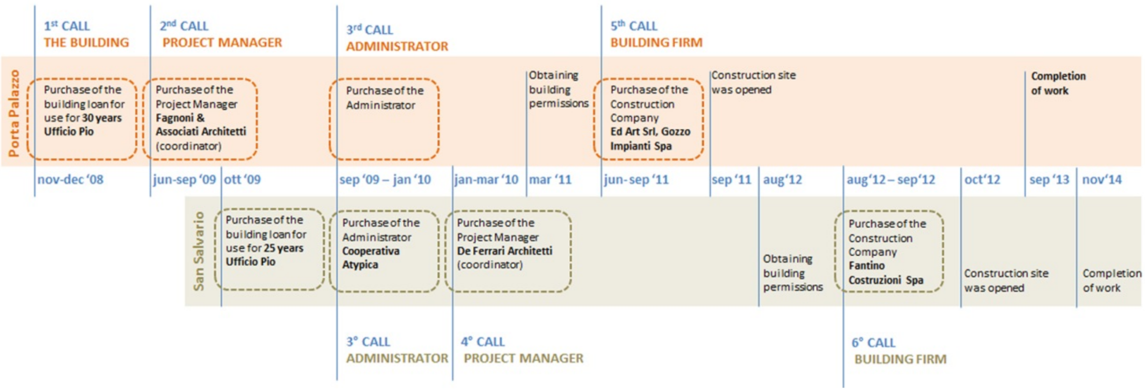

Fig. 3 The implementation procedures of the two temporary residence

In June 2009 and in december 2009, respectively for the building of Porta Palazzo and that of San Salvario, the Ufficio Pio, as commodatary, has called for two public tender with restricted procedure for assigning the "services concerning architecture and engineering for renovating the building": architectural survey, preliminary and final planning, project supervision, measure and accounts, coordination about safety and health during planning and realisation stages.

The public tender took place in two phases. In the first phase, for the pre-selection of candidates a Commission has shortlisted the applications that had been submitted (in total 48 for Porta Palazzo and 35 for San Salvario) on the basis of skills deduced from curriculum and from analogous experiences.

In the second phase the 12 shortlisted candidates have been invited to submit an offer. Then every proposal has been evaluated according to the criterion of the most economically advantageous offer on the basis of specific technical criteria[12].

In September 2009 the judging Commission has chosen the group of professionals Fagnoni & Architetti Associati of Florence with GPA Ingegneria Srl of San Giovanni Valdarno for piazza della Repubblica building. Afterwards, in March 2010 the judging Commission has chosen the group Studio De Ferrari Architetti in ATI, Cyd Consulting and ing. Marco Tobaldini for the project in via San Pio V.

In parallel with the definition of the requalification project for the building of Porta Palazzo, the Compagnia had to prepare a second call, to select the administrator (since the realisation procedures of the second

[12] The counted criteria are: methodological proposal, the percentage reduction in the estimated time for the completion of the service, architectural, functional, technological solutions, architectural solutions for a better management, construction techniques and materials with characters of green building technical and energy savings solutions.

Temporary Residence in the quarter of San Salvario were initiated at the same time – starting December 2009 – with the same public tender were chosen the two administrators for the two RT). Identifying the administrator in a preliminary stage of the planning development has answered the need to ensure a shared and active co-planning of all subjects involved.

Also in this case the selection was conducted in two phases, with a preliminary choice of the expressions of interest that had been invited to detail the proposal according to the instructions given in the relevant standard[13].

The call, that was closed in January 2010, led to the definition of working tables for coordinating the management and architectural characteristics, highlighting, even in this stage, the high complexity of the process. The actual administrator of Porta Palazzo temporary residence is Consorzio di Cooperative Sociali Kairòs, that of San Salvario will be Cooperativa sociale Atypica and Cooperativa sociale Progetto Muret.

In order to establish the performing and management requirements of the project it is also important to ensure that works are executed in compliance with the accepted standards, in order to get a high quality product, that is able to influence the future maintenance costs.

With another call for public tender, through negotiated procedure, in June 2010, the Ufficio Pio has invited 12 companies to submit a technical and economic offer, to be evaluated with the criterion of the most economically advantageous offer and in compliance with the Economic Technical Board of the project for the building in piazza della Repubblica.

In September 2011, following the selection of the building firm Ed.Art. SPA and Gozzo Impianti Spa, the construction site was opened.

Similarly, in September 2012, through negotiated procedure for awarding the execution of the work in the building of via San Pio V, the building firm Fantino Costruzioni SpA was selected. The construction site was opened in October 2012.

PORTA PALAZZO TEMPORARY RESIDENCE

MAIN FEATURES

Site	Torino, piazza della Repubblica 14 - Porta Palazzo
Type of intervention	refurbishment
Uses and purposes	temporary dwelling of social housing and commercial areas
Type of building	historical buildings of the XIX century
Receivers	single people, couples without sons, young workers, students
Flats	27 (13 one room flats and 14 two rooms flats)
Common spaces	polyvalent space, laundry room, and other spaces
Social activities	trade rooms, territorial cultural activities, restaurant
Timing (construction phase)	september 2011 / september 2013
Total SQM	2.250 sqm
Realisation cost	3.981.181 €
Construction cost	2.596.984 € - 1.154 €/sqm

Promoter	Housing Program of Compagnia di San Paolo/Ufficio Pio - www.programmahousing.org
Administrator	Kairòs Consorzio di Cooperative Sociali - Kairòs Casa, Esserci e Giuliano Accomazzi
Project Manager	Fagnoni&AssociatiArchitetti.
Construction Company	ATI EDART S.p.A. - GOZZO impianti S.p.A..

Fig. 4 Porta Palazzo temporary residence main features

13 The preferential criteria for evaluating the applications received are the following ones: documentable experience in managing similar structures; documentable link with the territory interested in the intervention; qualification and experience of the staff; participation in this notice as a group.

SAN SALVARIO TEMPORARY RESIDENCE

MAIN FEATURES

Site	Torino, via San Pio V 11/11 bis - San Salvario
Type of intervention	refurbishment
Uses and purposes	temporary dwelling of social housing, commercial areas, infant school, nuns housing
Type of building	historical buildings of the XIX century
Receivers	families with one or two parents and with minor sons
Flats	24 (6 one room flats , 10 two room flats , 6 three room flats , 2 four room flats)
Common spaces	common kitchen, laundry room, polyvalent space
Social activities	day care, commercial areas, erritorial cultural activities, infant school
Timing (construction phase)	november 2012 /november 2014
Total SQM	2.414 sqm (residential), 3.632 sqm (total)
Realisation cost	5.817.781 €
Construction cost	4.076.860 € - 1.122 €/smq

Promoter	Housing Program of Compagnia di San Paolo/Ufficio Pio - www.programmahousing.org
Administrator	Coop. sociale Atypica, Coop. sociale Progetto Muret onlus, Coop. sociale Luci nella Città onlus
Project Manager	Studio De Ferrari Architetti Associati
Construction Company	Fantino Costruzioni S.p.A.

Fig. 4 San Salvario temporary residence main features

4 CONCLUSIONS

The residence of Porta Palazzo, engine of new experiences and future experimentations, opened its doors to the city. On September 20 2013 the structure was inaugurated and the activities started, the systems were running regularly and the occupancy rate was greatly exceeded. The temporary residence has actively contributed to satisfy the housing needs beyond the initial expectations: six months after opening, the occupancy rate is 100%, whereas the occupancy rate estimated by the economic plan drawn up by the social administrator is approximately 60% for the first 3 years.

The theme of inclusion between this new urban "piece" and his neighborhood is still in place and not strengthened yet.

The process of social integration will be complex and will take some time, but at the end will bring the social housing residence to be an integral part of this quarter of the town and a service to its inhabitants.

In the meantime works in via San Pio V are in progress. At the end of the year the residence will start the activities for its inhabitants and its neighbors; the process of integration with the social context, in our opinion, will be easier in this case because the quartier is already available to welcome it.

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IMAGES SOURCES

Fig. 1: Giorgio Bombieri, Giulia Baù

Fig. 2: Studio De Ferrari

Figg. 3, 4, 5: Giulia Baù

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SMART COMMUNITIES

SOCIAL INNOVATION AT THE SERVICE OF THE SMART CITIES

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ABSTRACT

Making Cities Smarter is the challenge of the new millennium, even in a context of profound structural crisis like the present one. In fact, there is an urgent need to rethink the models of socio-economic development to make them more consistent with the new social needs, in particular related to the territorial liveability and social inclusion. In the literature produced in recent years and that has stimulated reflections, ideas, research and projects for a smart urban development, a "smart city" is generally meant as a city capable of joining "competitiveness" and "sustainability", by integrating different dimensions of development (economic, mobility, environment, people, living and governance*).* However, the actions have been largely focused on ICTs and their impacts on urban development.This contribution starts from a reflection, already begun by the authors, on the theme of "Smart City" as "Senseable city", which means that we need to focus the discussion no more on "how cities can be smarter" but on "how intelligent technologies can lead us to rethink the patterns of urban development by making them fair and inclusive, as well as efficient and sustainable". In this paper, the attention is focused on another aspect that in recent years is becoming increasingly important in terms of the development of smart cities, that is the *social innovation*, understood as innovative practice with the aim of creating a positive impact for society that is as wide as possible. The direct and indirect impact that the creation of social innovation can exercise in terms of urban development will lead us to talk about different models of Smart Cities as "Social Cities". Finally, investigating the Italian experience, the article shows how, despite the efforts, the current approaches to the problem are still very far from considering a Smart City as a local system focused on innovation, a system in which the application of new technologies is not random but responds to a strategic project that starts from the bottom, from the real needs of the citizen.

KEYWORDS

Smart city, Social innovation, Social City and Urban development

1 THE PARADIGM OF SMART CITIES/SMART COMMUNITIES: A CRITICAL READING

For some years first in the world and then in Europe, the researchers have been beginning to analyze the modern city through the paradigm of the *smart city*. The main feature of the smart city seemed to be on the role of ICT infrastructure, although much research has also been carried out on the role of human capital, the social and relational capital and the environmental quality as important drivers of urban growth.

Also various institutions and organizations have long devoted constant efforts to devising a strategy for achieving urban growth in a "smart" sense for its metropolitan areas. So, we can find in the Oslo Manual (2005), developed jointly by Eurostat and the OECD, the importance of role of innovation in ICT sectors but we also can detect that a method is provided to identify various consistent indicators, that form a sound framework of analysis on urban innovation. In particular, we observe renewed attention for the role of "soft infrastructure" (governance, innovation forums and network and community organizations) in determining economic performance.

As well as Caraglio and Del Bo (2009) have written, the availability and quality of the ICT infrastructure is not the only definition of a smart or intelligent city. Other definitions stress the role of human capital and education in urban development. Berry and Glaeser (2005) and Glaeser and Berry (2006) show, for example, that the most rapid urban growth rates have been achieved in cities where a high share of educated labour force is available. In particular Berry and Glaeser (2005) model the relation between human capital and urban development by assuming that innovation is driven by entrepreneurs who innovate in industries and products which require an increasingly more skilled labour force.

At the same time, we must remember what was pointed out by Hollands (2008). He affirms that this terminological vagueness could not be just a problem of defining a uniform framework for benchmarking but, behind a deliberate choice and an artificial generality, all the contradictions that characterize the new urban forms may be hidden.

However, without going into details of the various attempts to arrive at an univocal definition of a smart city, we can summarize the different ways in which it has been interpreted the concept of smart city into three types of approaches: (1) a techno-centered approach characterized by a strong emphasis on "hardware", new technologies and infrastructure that ITC would be the key to the smart city, (2) a human-centered approach where there is a large weight of social and human capital in defining the smart city; (3) an integrated approach that defines a smart city from the possession of both the foregoing qualities, because the intelligent city has to ensure integration between technology and human and social capital to create the suitable condition for a continuous and ongoing process of growth and innovation.

But even this interpretation seems still limited. In fact, if a smart city is a city that knows how to exploit their human capital so that there is a creative and qualified context for economic development, other factors that are not exclusively linked to economic growth seem very important.

In this regard, Hollands shows clearly that, today, there are no studies that correlate the smart city projects with the most critical aspects of the city and its transformations, as instead it had been when the entrepreneurial city was born (Harvey 1989), or when the dominance of the activities and neo-liberal spaces was increasing (Peck and Tickell 2002), and he emphasizes the risk that the smart city can be only a high-tech variation of the entrepreneurial city.

In fact, the growing assertion of the concept of territorial competitiveness that has had great influence on the way of understanding cities and development (through industrial clusters in Porter 2000, the innovative milieux in Scott 2000, and Nevarez 2003, or creative cities in Landry 2000, and Florida 2002), generating a process of enterprising of urban policies, was supported in the time by the guiding principle of sustainable development at the urban scale (Gibbs 2002; Gibbs and Krueger 2007). This has led to the development of other paradigmatic interpretations

such as: the "ecological city" (Platt 2004), the "compact city" (Breheny 1995), the "green urbanism" (Beatley 2000), up to the measurement of the "ecological footprint" (Wackernagel and Rees 1996).
Therefore, it is necessary to identify the criteria that make development aspects comparable to sustainability issues as well as issues of social justice in an urban scale. In fact, in the new "smart urbanization", processes of inclusion and exclusion can be born, that are worth to be observed and analyzed in a more consistent way.
As it is known, a first attempt to contemplate all these aspects in the definition of the smartness has been made by the Vienna University of Technology , in collaboration with the University of Ljubljana and the Delft University of Technology. They have produced a research on European medium-sized cities (with population less than 500,000 inhabitants). Later, this research became the ranking instrument of approximately 1600 city of EU27, plus Iceland, Liechtenstein, Norway and Switzerland.
This project, called "European smart cities", was born as part of a wider project ESPON 2013 (ESPON Project 1.1.1) and showed not only a final ranking of 70 cities, but it has remained a reference model to identify factors that make cities "smart". In this context, smart cities can be identified and ranked along six main axes or dimensions, that are: *a smart economy; smart mobility; a smart environment; smart people; smart living; and, finally, smart governance.* These six axes connect the traditional theories of urban growth and development, with the modern aspect of sustainable development of a city. Then, a middle city can be defined as "smart" when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance.
Starting from these dimensions of analysis, several other studies have been done (Boyd Cohen, City Protocol, Smart City in Europe, MIT Senseable City Lab, The European House - Ambrosetti , iCity Lab PA Forum, etc.).
Despite this, the whole design of smart cities, in terms of policies, plans and actions, was mainly oriented to engineering and selective interventions in comparison with the urban areas and portions of the population affected by them. The implemented measures concerned essentially the "high impact" sector (as the energy, the transport of goods, the mobility, the waste management, etc.), based mainly on high-tech solutions. Although sustainability has also been seen so far strictly in energy and environment key, through choices and technologies that save energy, or from a functional point of view, through integration of e-participation techniques such as online consultation and deliberation over proposed service changes to support the participation of users as citizens in the democratisation of decisions taken about future levels of provision.
Also at the European level, an attention toward the concept of smartness is confirmed. But there, the smartness is mainly read in the environmental and energy key. In fact, in the Strategic Plan for the Energy Technologies of 2007 (European Commission, 2007), and in the resulting Technology Roadmap (European Commission 2009), there is precise and explicit reference to the smart city and a specific budget dedicated to this axis.
Moreover, in 2012, the European Commission launched a specific initiative for the development of smart cities of the Old Continent: "Smart Cities and Communities European Innovation Partnership". This program has provided € 365 million for innovative ideas and demonstration projects within the energy, transport and ICT in urban areas. These policy (initiatives) are then witness to a European commitment to the sustainability of our cities, especially viewed in terms of technological innovation, in order to reduce the load of greenhouse gases and to improve the quality of the life of the citizens.
Therefore, a collection of "smart people" and "smart governance" appears necessary. Where, smart people refers to citizens aware of the importance of participation in public life, capable of peaceful coexistence, responsible for their choices in life. But a smart city is also a city that considers the population one of its most important resources for the future and who knows how to direct the development policies of the questions of the community in its various phases (for example services for the elderly or for children). While,

smart governance means an administration with a strategic vision of sustainable development, investing in communications and technologies for environmental sustainability and that is able to promote awareness-raising around the common good. A smart city must be a city that can support the establishment of public-private partnerships, able to involve citizens in decision-making in public policy, focusing more and more on participatory processes, such as online consultations and deliberations, as well as through the activation of participated creativity workshops. In this regard, it is interesting to take the warning issued by the sociologist and economist Sassen (2011), who believes that the new challenge is the attempt to "urbanize the technologies", that make them actually useful to new urban needs.

We need to think that a smart city is not a project but the beginning of an overall process of sensing and actuating for the transformation of the city, where there are particular needs of citizens, active and passive actors in the process. And, in the smart city, the dimension of equity must be held in due consideration. In particular, as described in the report "State Of The World's Cities 2012/2013, prosperity of Cities", the equity must take account of the distribution and redistribution of the benefits of prosperity of a city, in order to obtain a reduction of poverty, a supply of adequate housing, a protection of the rights of minorities and vulnerable groups, a gender equality and a public participation of citizen in political and cultural life.

So, the equity is the new dimension that completes the process of smartness ensuring the development of a city in terms of *SENSEable City*: a city should be not only smart, but its smartness must cover all the inhabitants.

If the "Smart City" is a city where the investments in human and social capital, in the participation processes and in the technology infrastructure, are directed to sustainable and competitive economic development, "the SENSEable city" is the one that encourages dialogue between the different actors of the urban reality, and that promotes more informed decisions for the development of the city in all its parts and components, with a new participatory approach to urban development and with a more efficient and equitable use of resources and networks (Greco and Bencardino 2014).

2 SMART CITIES AND SOCIAL INNOVATION

The rapid spread of the concept of "smart city" - think more and more like the "city of tomorrow" - has led to the growth of a strong debate about innovation, not only the technological one, but *social and open innovation* and on how to involve community in the processes of innovation as a key element of urban regeneration of urban areas.

A theme, that of social innovation, that opens to a new dimension to the definition of intelligence of a city, where its technological facilities, networks and all intangible infrastructure, cloud computing and electronics are to be understood only as instruments whose value is in the finalization towards objectives of smart growth, sustainable and inclusive of cities.

Assuming this perspective, the concept of smart city is inextricably linked to that of social innovation. In this vision, the Smart cities are cities that create the conditions of governance, infrastructural and technological to produce social innovation, able to solve social problems related to growth, inclusion and quality of life, through listening and the involvement of various local actors: citizens, businesses and associations.

There are many definitions in the literature of "social innovation" that demonstrate the complexity of establishing analytical boundaries of a phenomenon whose essential characteristics are manifested in practice.

Some of the earliest references to social innovation dating back to the 1960s, when the term is used to refer to experimental research within the social sciences and humanities. Since then, the term has gone on to be used in reference to different areas: by the processes of social change and the transformation of society as a whole (Porter, Kramer, 2011), to an aspect of the business strategy and organizational (management of non-profit), to social enterprise and social entrepreneurship (Hoogendoorn *et al.* 2010), to the practical development and implementation of new products, services and programs which meet social needs (Murray *et al.* 2010), and finally, as a "process" of governance, empowerment and the development of social capital in the implementation of specific programs and strategies for an inclusive city (Gerometta *et al.* 2005)[1].

In this paper, refers to this latter viewpoint, according to which is social innovation that innovation that provides new answers to old and new social problems. It is, therefore, an innovation that emerges, on the one hand, as a response to a growing dissatisfaction with the technological emphasis in economic innovation literature and innovation policy (Moulaert *et al.* 2005), on the other hand, as a response to the growing social, environmental and demographic challenges, expression of the "failure" of the modern Welfare State, of conventional market capitalism, of mass urbanization, of globalization and its negative impacts and so on (Nicholls and Murdock 2012).

One of the definition of social innovation more open and complete at the same time is contained in the "Open book on social innovation", written by Murray, Caulier-Grice and Mulgan (2011), which define social innovations as new ideas (products, services and models) that simultaneously meet social needs in a more effective of the alternatives exist and create new social relationships or collaborations. The authors describe the Social Innovation as a phenomenon that starts from the bottom, impetuous and spontaneous that does not require abstract solutions, but new and concrete actions that depart from the modern society under the influence of disruptive new generation, made of stubborn young and enthusiastic, ready to get in the game.

Phillis, Deiglmeiere and Miller, in their article for the "Stanford Social Innovation Review", define social innovation as a new solution to a social problem that is more effective, efficient and sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals. Other authors as Everett M Rogers (1995) and Gillwald write on this aspect, emphasizing that an innovation to be such need not be new, but rather, new to the territory, sector or field of action of the innovation itself, a "social achievement" that provides the best solutions.

Manzini, an expert in sustainable design, defines "social innovation" the way in which individuals and communities act to solve a problem and generate new opportunities. In this sense, innovation is a catalyst for social change, a collaborative process through which citizens can be directly involved in defining the ways in which a project, a program or service is designed and then implemented.

Other authors consider innovation essentially as "product", defining social innovation as the realization of an idea that leads to specific outcomes, such as improving the quality of life or social inclusion. Still others, such as Eduardo Pol and Simon Ville (2008), define social innovation in terms of "impact": the innovation is a social innovation if the new idea has the potential to improve both the quality and quantity of life (better education, better environmental quality, better life expectancy and so on).

Other definitions focus, instead, on motivation: Harris and Albury (2009), for example, define social the innovation that is explicitly inspired by and directed to the social and public good.

In the European vision, the innovations are social whether the objectives and the means used to achieve them are social (European Commission 2013) [2].

Beyond the definitions and visions, whether they intend to social innovation as a novelty, a process, a product, an impact, a motivation or as a combination of these, it is clear that social innovation is another to innovation tout court that arises from market competition and the search for a higher profit. At the origin of these innovation processes are social pressures exerted by the existence of unsatisfied needs (e.g. health services of proximity), of wasted resources (e.g. land use), environmental emergencies (e.g., air quality) or social (e.g. growing areas of hardship, poverty and marginalization).

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1 For a review of the literature see: Tepsie FP7 Project, "Defining Social innovation" – Part 1. May 2012.

2 European Commission, DG Regional and Urban Policy, "Guide to Social Innovation", February 2013, http://ec.europa.eu/regional_policy/information/brochures/index_en.cfm#1.

In the definition and development of smart cities, the social innovation, therefore, is not only a more or less radical idea, but an innovative practice that aims to create a positive impact for society that is as wide as possible. It is to be understood as the capacity, the ability, the strength of a society to understand, analyze and solve its social and environmental problems and takes the form of ideas, actions, strategies, processes and projects whose impact is to the benefit of the community and not individual promoters. The practices of social innovation, in fact, not only respond in an innovative way to some needs, but also offer new ways of decision and action, through the creation of networks and using forms of coordination and cooperation rather than vertical forms of control.

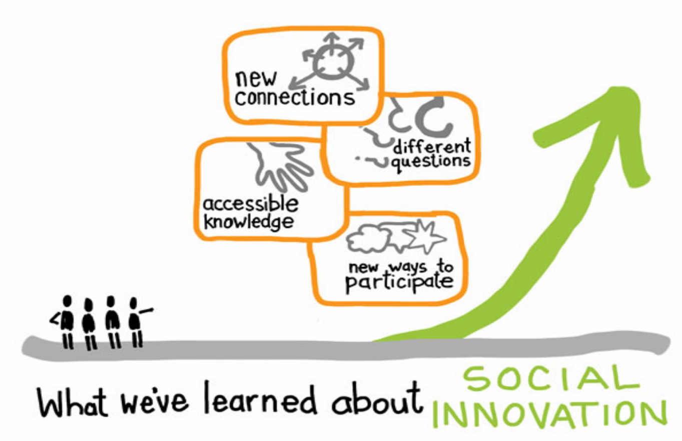

Fig. 1 About a focus on social innovation

Another key aspect that ties the theme of social innovation to that of smart cities, is the field of action of social innovator. According to Mean and Tims, the Report's authors "People Make Places: Growing the Public Life of Cities", public spaces function as self-managed public services because they create "a shared resource space in which the experiences and values are created in ways that are not possible simple in our private lives". This means that the public space is interpreted as an experience created by the interaction between people, rather than as a predetermined physical place. This interaction contributes in turn to create a sense of community that is a crucial element in the process by which citizens relate to their surroundings and participate in the creation of models of socio-economic development more consistent with the changing needs and new social needs, in particular, related to the livability of the area and social inclusion.

The potential impact of an innovative practice on the social context is much higher as inclusive as is the process of community involvement, an involvement not passive, but projected to action: the community does not participate only at the phase of experimentation and testing of application solutions proposed, but answers to the problems of their living places by developing specific projects (Harris and Albury 2009).

Another of the most important and controversial aspect of social innovation concerns the measurement of the impact that it can exercise in social terms. The strong focus on the evaluation of this impact has resulted in the development of metrics and tools for the quantitative measurement of the social value created.

The impact of innovation is, in reality to evaluate both in the direct creation of social value generated by the results of a social nature closely related to the action/innovation, both in the indirect creation of social value generated from results implied in the process, in the new relations, in the new governance structure, in the social capital activated. The indirect creation of social value consists, in fact, in increasing capacity for action of society (*empowerment*), thanks to a process of collective learning (Gerometta *et al.* 2005). From here, also, the usefulness of networking of individuals that make social innovation and their practices for defining and shares development projects for smart cities. The two value dimensions help to determine the *outcome of innovation*, or what is defined social improvement.

One last aspect to be discussed is that of governance: the social innovation is embedded in the social system of the communities in which they practice, in the qualitative value of these relationships, in the complexity of spontaneous models of governance. There are no, in fact, actors and sectors more suitable than others in developing practices of social innovation. Indeed, the most interesting experiences and radicals are the result of collaboration between different actors belonging to different worlds.
The one that emerges is a new community, where the local dimension is integrated with the global within the city and where the resources and the know-how of the people are valued because they are considered important tools for the solution of problems related to urban and cultural sustainability. Here the innovation becomes an a catalyst for social change, a collaborative process through which citizens participate actively in the development and implementation of projects, programs and services aimed at them. The passage from the vision of the control to that of enabling transforms the city into hub for empowering communities: holistic and living spaces in which people make heard their voices and, starting from their daily experiences, driving change.

3 SOCIAL CITIES: MODELS OF "SMART CITIES" BASED ON SOCIAL INNOVATION

In the model purely "smart" the technologies on the one hand transforming the city into a system of services and infrastructure characterized by extremely efficient management processes, on the other hand offer versions "personalized" of the urban ecosystem through pervasive devices to search and reporting (Hollands 2008). Examples of actual "smart cities" include towns built from scratch like New Songdo in South Korea and Masdar in the United Arab Emirates, but more often existing cities that are made "smarter", like the Amsterdam Smart City project in the Netherlands. The policies stop to this model of smart city consider innovation in its purely technological and economic dimension and the citizens as end-users, according to that which can be identified as the urban logic of 3C (consumer, control, capsulerization).
In reality, as technology is only one aspect in the analysis of possible scenarios of urban development that arise from the widespread diffusion of so-called "intelligent technologies" which, although focused on efficiency and comfort, will inevitably have an impact on patterns of typical urban life and social challenges (Crang and Graham 2007). Focusing on how intelligent technologies can create social innovation, from an interpretation "technocratic" of smart city will change to a "social": according to this view, the city becomes "Social City" when the question that drives the analysis and field trials is "whether and how digital technologies can make possible the action of citizens on collectively questions perceived as important and urgent".
The Social City explores how digital media technologies can enable people to act as co–creators of livable and lively cities, what is called "civic empowerment".
According to this approach, the urban technologies engage and empower people to become active in shaping their urban environment, to forge relationships with their city and other people, and to collaboratively address shared urban issues (Paulos *et al.* 2008; Foth *et al.* 2011; De Lange and De Waal 2012).
The home page of the Social Cities of Tomorrow website - International conference & workshop in Amsterdam, the Netherlands (14-17 February 2012) - opens with the following statement: "*Our everyday lives are increasingly shaped by digital media technologies, from smart cards and intelligent GPS systems to social media and smartphones. How can we use digital media technologies to make our cities more social, rather than just more hi-tech*?
Much has been said and written about changing spatial patterns and social behaviors in the "smart city" as "media city"; yet, less attention has been paid to the question how urban new media shape the built form (De Lange and De Waal 2013). Systematizing approaches and experiences emerging in European cities, but

especially in North America, De Lange and De Wall argue that there are three areas of the most promising developments,

in which urban technologies can be used to create "smart cities" based on social innovation, through the active involvement of citizens: i) data-commons; 2) sense of place and sense of belonging (ownership); 3) DYS (Do It Your Self) Urban Design and Networked Publics.

In relation to these three areas, we try to delineate several models of "smart cities" based on social innovation[3]:

- *"Open City*: is the city that gives priority to the transparency of its work. The communication of its activities is not mediated but is directed by the online publication of all acts, live broadcast streaming of council meetings, access to documents, and so on. Is with the adoption of open data model that this approach has found its maximum expression in many American and European countries and, more recently, also in Italy with the experiences of Udine, Turin, Florence. The San Francisco's Open Data Platforms, for example, are the most interesting in the world. San Francisco is not (only) the city of The Open Data, but the one that has "institutionalized" social innovation, creating an ad hoc municipal office and a team of eight young experts to transform the city into more accountable, accessible and responsive to America.
- *"Owned City o Wiki City"*: the communication is intended to encourage the involvement of citizens in the management of public affairs. From the first experiments of e-democracy to the recent experiences of public contexts and wiki-government, citizens are called to become an active part in decisions that affect the city. Concrete examples of this approach are the experiences of Bologna and Cagliari.
- *The "City as a platform" or "Cloud city"*: the urban space with its streets, squares, parks has always been a precondition for social interaction. In the city as a platform, the technology becomes a facilitator of interaction, software of connection between ideas, initiatives, skills and different experiences or, as says Cerveny, (Founder and Director of VURB an European framework for policy and design research concerning urban computational systems) the operating system of civil society able to "combine the reach of the cloud with the power of the crowd". There are those who denote this feature as MAAS, Municipality as a Service taking as a model the approach pursued by the city of New York that one of the first cities in the world has made explicit its model of digital development through a development plan, the Road Map for Digital City, aimed at "create an ecosystem that enables both transparency and also economic growth" (Rachel Sterne Interview, April 28, 2011).
- *"Neo-bohemian" City or "Creative City":* is the city that gives space to the communication that comes from the bottom in the form of artistic production, creating the conditions for the regeneration of urban areas. The neo-bohemian neighborhoods are laboratories for research and development for the production of the economy of entertainment, of media, of advertising, of work related to aesthetics.
- *"Resilient City":* the synchronic processes of assimilation and adaptation to which, by their nature, shape, structure and functions, the urban systems (urban centers such as the suburbs) are continually exposed, as well as the deep crisis that has affected the contemporary city is no longer seen as places of production but only of consumption, has led recently to the declination of the concept of ecosystem resilient linked to that of smart city. It is associated with a particular idea of intelligence that can reshape to the complexity of the events that are deconstructing the city. At this same idea, several authors have reconnected other paradigms such as urban regeneration, that proposes in place of the

[3] For a review of international and italian case studies see: Camporeschi C. (2010), Enabling City: Place-Based Creative-Problem Solving and the Power of the Everyday, The Enabling City, available on www.enablingcity.com; Murray et al. (2011), "The Open Book of Social Innovation", The Young Foundation, available on www. http://youngfoundation.org.

now ineffective sustainable development, and of connective intelligence Network and System (Davoudi 2012). The ability of a society to create a constant flow of social innovations is an important contribution to its social and ecological resilience (Westley 2008).

4 A LOOK AT THE ITALIAN PROGRAMMING FOR THE FUTURE

"Social innovation" and "smart city" are two concepts that have been supported by the Italian Ministry for Education, University and Research (MIUR) through the action lines defined in two public calls, that had the same denomination "Smart Cities and Communities and Social Innovation": a first, funded under the PON for Research and Competitiveness (DD no. 84/Ric. of March 2, 2012) dedicated to the Convergence Regions and a second (DD no. 391/Ric of 5 July 2012), in which the Ministry of Education had allocated 665.5 million euro (of which 170 Meuro as a contribution in spending and 485.5 Meuro for subsidized credit) for the presentation of Project Ideas by companies, research centers and consortium companies, located throughout the national territory[4].

Through these public calls, the MIUR was aimed to identify measures and collect ideas to solve problems at the urban and metropolitan scale in sixteen specific areas (*Territorial protection, Ageing Society, Welfare Technologies and Inclusion, Home Automation, Justice, Education, Waste Management, Technologies of the Sea, Health, Transportation and Mobility, Last-Mile Logistics, Smart Grids, Sustainable Architecture and Materials, Cultural Heritage, Water Resources Management, Cloud Computing Technologies for Smart Government*).

For both public calls a share of the budget - amounting to 40 Meuro for the first call and 25 Meuro for the second one - was aimed at young people, aged up to 30, who wish to submit projects for *Social Innovation*. These selections shows the importance that the MIUR reserves to the theme of smart communities and social issues. So, these initiatives has been well received by a community of young innovators who have submitted projects often very complex and articulated, despite the economic resources for the Social Innovation were much more limited than the Project Ideas financed with the same public calls. This is an absolutely bottom-up process, which starts from instances of local communities, but needs stimulation, support and coordination from the top to be able to maximize the benefits that these planned actions can produce.

For Social Innovation, many of these under-30 have proposed concrete solutions to solve the problems of the urban contexts in which they live and work. Considering only the four Convergence regions, we can mention more than 60 funded projects and, above all, more than 200 "social innovators" engaged in the development of proposals approved in the first call. Moreover, many funded projects have aroused the interest of local administrations, that have effectively included these in its initiatives directed to objectives of "smart city". In addition, we note that some of these appear very complex and ambitious[5].

Looking only to the city of Naples, an interesting example is the project named OR.CH.E.S.T.R.A. (Organization of Cultural Heritage for Smart Tourism and Real Time Accessibility). In this case, the initiative has not only brought huge resources, but also has stimulated the interest of the insiders. This initiative provides for the enhancement of the city's cultural heritage through the development of a platform that will allow the search of multimedia data collections and the creation of personalized tourist routes[6].

Many other projects for the city of Naples have the goal of creating a smart city through social innovation: the project "A.ppI.L. Health", the project of public wi-fi network "Naples Free Cloud City", the "Aquasystem" project aimed at improving efficiency of the management of environmental resources, and, finally, the

[4] http://www.ponrec.it/programma/interventi/smartcities.
[5] http://www.ponrec.it/notizie/2012/maggio/smart-cities-and-communities-approvazione-delle-idee-progettuali.
[6] http://www.ponrec.it/media/140152/presentazione_miur_orchestra.pdf.

projects “Naples Bike Sharing” and “CI.RO. - City Roaming”, aimed at the development of sustainable mobility, respectively for the cycling network and the urban mobility.

All of these projects mentioned seem to be well integrated within a complex initiative and focused more on areas of intervention. In particular, this last one is a very complex project in terms of management and implementation. It provides a network of actors called upon to support the group of young innovators: the Municipality of Naples, the company Napolipark Srl (to which the Administration has entrusted the management of the services stop, the mobility and the video surveillance) and three leading ICT companies (ABB, Renault and Vodafone). The presence and support obtained from these last three actors testifies to the great effort and commitment of the proponents in the definition of a group of solid work, and with high skill in integrating new technological equipment in the city (http://www.cityroaming.org).

In summary, we can count as many as 32 Executive Projects, which are combined with 48 Projects of Social Innovation, for a total of 399 participants coming mostly from private enterprise sector but also from that of research and institutions. Some of the projects co-financed by the PON for Research and Competitiveness in the South were presented in Naples March 27, 2014 at the “Smart City med”.

As all the social innovation projects funded with the public calls "Smart cities and communities and social innovation", the work began recently and, therefore, the results are not yet fully evaluated, but the expectations are really high. Similarly there is a high confidence in this new approach to innovation. In fact, many Italian cities have decided to open new calls to retrieve ideas and proposals from the local community, with particular reference to the involvement of young talent present in it, more and more possible protagonists of the transition of our urban areas towards a new model of the city.

But the MIUR calls have also reserved some surprises and mishaps. First of all, we must denounce the temporal slowness with which they were conducted selections and subsequently signed the decree of final approval of the 80 winners. The decree of approval of the lists was signed October 31, 2013, after more than a year since the publication of the second call of July 5, 2012. Then, we also report a reduction of about 50% of the amount initially allocated. In fact, after the decree of approval, the MIUR as made technical visits and scientific verification on site to approve the costs of individual projects and the result was a restatement of these project costs. Finally, total costs were admitted for less than € 350 million, which amount to less than half of the financial resources made available by the initial announcement, which were 655.5 million euro. And also, a little more than € 305 million of this € 350 million will be financed partly in the form of a contribution to the expense (non-repayable) and partly in the form of subsidized credit; the rest will be covered by private co-financing.

In conclusion, although it is too soon to express a full review, some observations can already be made. At first, we can say that the verifications in the final approval appear more than justified, because of the abuses that have been made in the past of the public money and the failure of the non-repayable grant. Therefore, although the delays and reductions in the budget may appear to be a malfunction in the selection process of Project Ideas, we think they are useful for a correct direction of the resources. Secondly, we must point out that reserve a significant portion of the design for smart cities to social innovation is a nullifying point for understanding that a smart city is a city that starts from its citizens. Finally, it seems important to emphasize that the choice of bottom-up selection is certainly a successful choice because it starts a series of youthful energies otherwise unused. Then, we hope that this mode of bottom-up selection could represent a model for the future organization of the smart city.

NOTES

Although the paper grounds on a common research work, the abstract e the paragraphs 1 and 4 have been written by M. Bencardino; the paragraphs 2 and 3 by I. Greco.

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IMAGES SOURCES

Fig. 1: From the website “Common Knowledge”, http://ckgroup.org/ essential- strategies/ overview/ social-innovation/.

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ONLINE CITIZEN REPORTING ON URBAN MAINTENANCE:

A COLLECTION, EVALUATION AND DECISION SUPPORT SYSTEM

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ABSTRACT

We present an online support system for urban maintenance which: 1. lets citizens directly report neighbourhood issues which may require attention from the urban maintenance services: 2. evaluates the priority of reported issues; 3. allows the allocation and management of resources and workforce on solving issues and 4. permits public tracking of their status.

The web application was entirely developed using low-cost Google cloud services, with the advantage of low deployment and hosting costs and practically no systems administration costs, a highly replicable and transferrable solution, and a rapid development process relying on robust Google services. The model for evaluating priority of reported issues is based on the the ELECTRE TRI rating method.

In the paper we present the system's standard workflow, the evaluation model and the implementation details. We also discuss its possible more general implications for fostering and supporting citizens participation.

Unlike many existing platforms for citizens reporting of maintenance issues, our system incorporates an explicit and publicly accessible evaluation model to prioritise issues and assign resources for their solution. This, we argue, is a crucial prerequisite for the principles of transparency, publicity, accountability and equity be observed by municipal governments.

KEYWORDS

Online citizens reporting, Evaluation and decision support system, Urban maintenance, Participation, Priority sorting, ELECTRE TRI

1 INTRODUCTION

All is good on Axiom. People consume, robots work. Few things break down or get dirty, and when they do, nobody needs to report it, decide what to do about it and where to start from. Robots are everywhere, cleaning, repairing, maintaining everything, effortless and snappy.

On Axiom, the starliner from Pixar's film WALL-E, this paper is useless. Here on Earth, city affairs are a little different: things break down and get dirty all the time, there are no all-present and all-seeing robots patrolling, fixing and cleaning things, it isn't an effortless and snappy job, and those who are there to do it cannot see everything, have limited resources and time, need to decide where to start first, possibly explaining why to citizens. A day perhaps will come when WALL-Es will be around, but in the mean time we should put to service existing technology to assist us in these urban chores.

We here present one such web-based support system for urban maintenance. The main purpose of the system is to allow citizens to report neighbourhood issues via Web, and to integrate it into the workflow of the city maintenance services operations. Such direct citizens' reporting of neighbourhood issues – ranging from damaged infrastructure, roads, signs and buildings, to abandoned waste, to untidy places, to acts of vandalism, and so on – is less a technological challenge than it is an problem of public policy. Indeed, as we discuss with greater detail in Section XXX, the available Web and mobile technologies and infrastructures make the collection of citizens' reports and suggestions on issues of urban maintenance reasonably straightforward from the purely technological and implementational point of view. What instead come to the fore are the issues of organisational impact on the municipality, and above all the impact on the nature and the quality of public policy, and the general principles that (should) inform it. Therein, if anywhere, resides the grain, if any, of originality of this work: not so much in the technological and implementational aspects of the solution itself, but in few "special ingredients" which, we hold, may play a decisive role for promoting certain principles and qualities of public policy. Principles and qualities for which no better words come to our mind than greater democratisation.

We will touch all these different facets in what follows. We begin by enunciating in Section 2 the public policy principles we believe municipal governments should observe. These principles therefore served as the most general objectives and meta-requirements for our application.

Then, in the Section 3 we briefly discuss some recent trends and experiences which were sources of inspiration for us, but we also point at their shortfalls. We argue that there is usually a "missing link", and then go onto presenting our version of that special ingredient in Section 4.

Sections 5. is dedicated to a more detailed description of the system and the standard workflow from citizen's report to issue resolution, and presents examples of interfaces and system's outputs.

Section 6. provides some details about the implementation of the Web-based application.

Finally, in Section 7. we make few remarks and draw some conclusions on the possible implications of our system on the citizens participation and public policy.

2 PRINCIPLES OF PUBLIC POLICY AS DESIGN OBJECTIVES AND META-REQUIREMENTS

There is a set of principles we believe municipal governments should in general observe. These principles served as the most general objectives and meta-requirements for the design and integration of featured in our Web support system, so it is worthwhile to list them and see how they reverberate on our specific problem.

Openness and inclusivity. Citizens should be given a clear, publicly known and non-discriminatory access to the possibility to report (and propose solutions) for neighborhood issues.
Transparency. All the reports, proposals, alternatives, constraints and any other information relevant for decision-making should be known to citizens, easily accessible, clearly presented and made understandable.
Publicity principle. In the general Rawlsian conception (Rawls 1971), the publicity principle bans government from selecting a policy that it would not be able or willing to defend publicly to its own citizens. In our case, this relates to the key feature of our system: the decision support for prioritising citizen-reported issues. So a local implementation of the publicity principle should ensure that the reasons for a decision to prioritise one rather than another citizen-reported issue should be explicit, as much as possible non-arbitrary and grounded on some "public reason".
Accountability. The decision-makers should openly acknowledge and assume the responsibility when they exercise their discretionary power of choice and decision.
Equity. Distributional considerations among neighbourhoods should count. Given the inevitable constraints of resources and time, these should be distributed among citizens living in different neighbourhoods according to some principle of equal treatment.
Our support system is an attempt to provide a software infrastructure with application logic which would allow the implementation and the adherence to those principles by a municipal government. This whole field of using "citizens as sensors" has seen a remarkable advancements with the advent of the Web 2.0 and mobile technologies. Many Web applications and mobile apps already exist to let citizens report neighbourhood issues. Yet many also feature a crucial lack, a missing link we want to bring to the fore and address.

3 THE MISSING LINK

The wave of Web 2.0 and mobile apps has produced countless systems and platforms for collecting citizens reports and suggestions on issues of urban maintenance. The most mature and widely used solutions often share a common set of features allowing citizens to describe, classify and sometimes place issues on a city map, to comment, vote and track them. The system administrators then usually have the possibility to flag issues to signal their status (e.g. "received", "in progress", "resolved") and thus permit their public monitoring. Some systems also allow dialogue and exchange of comments between the administrators and the citizens.
These solutions are available on a variety of platforms and use various hosting and application providing models. There are nation-wide services the municipalities can opt into, like multi-platform multi-device *City sourced*[1] in the USA, the web-based decorourbano.org[2] in Italy and Cidade Democrática[3] in Brazil. Some are standalone applications directly hosted by the municipalities, like Boston's multi-device Citizen's Connect[4] and City of Venice's web-based system IRIS[5]. Few interesting experiments are also starting to emerge around popular social networks, like the Brazilian Urbanias[6] developed for Facebook.
Among all the things they have in common, these platforms also share a common shortfall. While they have by and large successfully settled the technicalities of how citizens could report, comment, vote and track

1 www.citysourced.com.
2 www.decorourbano.org.
3 www.cidadedemocratica.org.br.
4 www.cityofboston.gov/apps.
5 iris.comune.venezia.it.
6 apps.facebook.com/urbanias.

issues, the missing link is the lack of an explicit, transparent and publicly accessible evaluation model to prioritise issues and to assist the assignment of resources for their solution by the municipal government. To speak in terms of the general principles from Section 2, the systems mentioned may well grant greater openness and inclusiveness, possibly a somewhat better transparency, but the publicity principle, accountability and equity may only be assured if the criteria and the constrains for choosing which issues to fix when are publicly known (possibly after a public debate).

The system we present here is an attempt to show how this missing link – the evaluation model for prioritising issues – may be provided. What is relevant in our case is both that there is an explicit evaluation model, and that it is made publicly known.

4 THE EVALUATION MODEL FOR PRIORITISING ISSUE

The purpose of the evaluation model is not to automatically provide a complete ordering of all the reported issues. It is rather a guidance and a hinting tool. That is why we held it appropriate to adopt a rating evaluation model which classifies issues in priority classes.

4.1 DATA COLLECTION AND EVALUATION ON CRITERIA

The classification of reported issues by priority is a multiple criteria problem, viz., to assign each issue evaluated on a set of criteria to one and only one class of priority. The evaluations on the criteria are derived from the online form by mean of which citizens report issues. Among other relevant information (type of issue, place, photo, and so on) the system asks citizens to answer several multiple-choice questions, reported in Table 1. This information is essential for the subsequent evaluation and rating of the issue.

QUESTIONS	POSSIBLE ANSWERS (VALUES USED IN THE EVALUATION MODEL IN SQUARE BRACKETS)
1. Is there a serious hazard for human health and security?	Yes, for sure [4] – Probably yes [3] – Probably no [2] – Certainly no [1] –I don't know
2. Are there waste and materials hazardous for the environment?	Yes, for sure [4] – Probably yes [3] – Probably no [2] – Certainly no [1] –I don't know
3. Does the issue obstruct natural flows and functions (e.g. water streams)?	Yes, for sure [4] – Probably yes [3] – Probably no [2] – Certainly no [1] –I don't know
4. Is there a risk the issue to cause traffic incidents?	Yes, it has happened / was about to happen [4] – It is possible [3] – Probably no [2] – Certainly no [1] – I don't know
5. Does the issue obstruct the circulation of vehicles?	The final destination is completely inaccessible [4] – It is necessary to take alternative route to reach a destination [3] – The circulation is not obstructed but only slowed down [2] – It doesn't obstruct the circulation in any way [1] – I don't know
6. Does the issue obstruct the pedestrian routes and footpaths?	The path is completely obstructed [4] – The path must be avoided [3] – It is possible to transit but the circulation is slowed down [2] – No, it doesn't significantly obstruct the transit [1] – I don't know
7. How many people daily visit the place on average?	A lot (more than 500) [4]– Quite many (from 200 to 500) [3] – Not many (from 50 to 200) [2] – A little (less than 50) [1] – I don't know
8. How visible is the issue?	It can be immediately seen and it's very extended [4] – It can be seen if looked at [3] – It's hard to see [2] – It's barely visible [1] – I don't know

Tab.1 Multiple-choice questions used for the evaluation and priority rating of issue

These eight questions/criteria are specific to one specific implementation of our system. What matters here for our general discussion, of course, is the general logic, not that there have to be these eight questions, nor that they have to be eight.

There are, of course, two standard problems with the approach of collecting evaluative information directly from citizens. One is related to the inevitable uncertainty of interpretation and fuzziness when expressing evaluative judgements, so different citizens may give different meanings to questions and scales of answers, classifying and describing differently the same issue.

The other problem is the possibility, even a strong likelihood, of strategic behaviour: knowing that different answers may induce different responses and actions by the municipal maintenance services provides incentive to citizens to overemphasise the gravity and urgency when reporting issues.

These are hard problems hard to eradicate. On the long-run it requires social learning and development of trust in the institutions and among citizens. In the mean time, we think a few practical countermeasures may be devised. First, to construct questions and possible answers (scale) in as natural and comprehensible a language as possible. We're not sure how successful we were in our attempt, and no doubt there is space for improvements, but it is a good general principle to follow. Second, the information provided by citizens are not directly feed into the evaluation model: the back-office operators who receive the information through the system serve as arbiters who validate, interpret, uniform and re-codify the information submitted to the system by citizens. In addition, the internal workflow may also contemplate the possibility of sending out inspectors for direct observation on the field.

4.2 THE EVALUATION MODEL

Among the methods for multiple criteria evaluation of ratings (Bouyssou et al, 2006), we have adopted the so called ELECTRE TRI model (Yu, 1992; Roy and Bouyssou, 1993). It is a prominent classification approach, and a natural candidate for our task for it possesses several desirable properties: (1) it allows a complete sorting of issues in priority classes, and the aggregation over multiple criteria is fairly flexible, permitting to account for (2) the importance (weights) of criteria, (3) coalitions (majority rule and threshold) and (4) possible veto powers.

There is another important advantage of the ELECTRE TRI method: it is reasonably easy to communicate and be intuitively understood by citizens. For things are simpler than they seem. We will try to show this through an example.

Ideally, the model parameters – weights of criteria, majority and veto thresholds – should be defined by decision-makers and subject to public debate. We have developed the application for Alghero in Italy, a city of 45.000 inhabitants. The Town Councillor of Alghero responsible for the City Environment and Waste Management, has, through a structured interview, arrived at the following model parameters:

- weights of criteria wi (following the order in Table 1): 0, 0.2, 0.1, 0.15, 0.15, 0.1, 0.15, 0.15 (note that the first criterion has zero weight but, see below, a decisive veto power);
- majority thresholds = 0.6;
- veto power by the first two criteria (human health/security, and environmental hazard), with veto thresholds v1 = 0 (meaning that issues should at least be assigned to the priority class of the health/security criterion) and v2 = 1 (which assures that issues are classified at least one class below the value of the environmental hazard criterion).

Let us now illustrate the classification procedure with these model parameters, using a simple example. Suppose there are three reported issues – a1, a2 and a3 – with the evaluations on the eight criteria given in Table 2.

	h_1 (0)	h_2 (0.2)	h_3 (0.1)	h_4 (0.15)	h_5 (0.15)	h_6 (0.1)	h_7 (0.15)	h_8 (0.15)
a_1	4	2	3	1	2	3	4	3
a_2	1	2	1	3	4	3	2	4
a_3	1	4	3	1	1	2	1	3

Tab.2 Example evaluations of four issues on eight criteria; criteria weights in parenthesis

These three issues present three notable situations that may arise given the model parameters specified above.

The issue a_1 is classified in the highest-priority class C^4 ("urgent issues") because, no matter the evaluations on other criteria, the issue's belonging to any other class would be discordant due to the veto power of the criterion h_1.

The issue a_2 belongs to the class C^2 ("notable issues"). In fact, the sum of weights of the criteria for which a_2 belongs to the class C^1 or higher is of course 1, of those for which a_2 belongs to C^2 or higher is 0.9, of those for which a_2 belongs to C^3 or higher is 0.55, and of those for which a_2 belongs to C^4 or higher is only 0.3. Therefore, according to the rule (1) and given the majority rule with the threshold of $\lambda = 0.6$, the issue a_2 belongs to the class C^2. No veto power is violated with this attribution, given that a_2 is evaluated 1 (lowest priority) on the first and 2 (second-lowest priority) on the second criterion.

The issue a_3 is classified in the second-highest-priority class C^3 ("pressing issues"), Here, the sum of weights of coalitions for the four classes are respectively 1, 0.55, 0.45 and 0.2. So, according just to the majority rule, a_3 would belong to the lowest-priority class C^1. However, the veto power of the second criterion h_2 with the threshold $v_2 = 1$ imposes the issues be classified at least one class below the value of that criterion. Since $h_2(a_3) = 4$, therefore $a_3 \in C^3$.

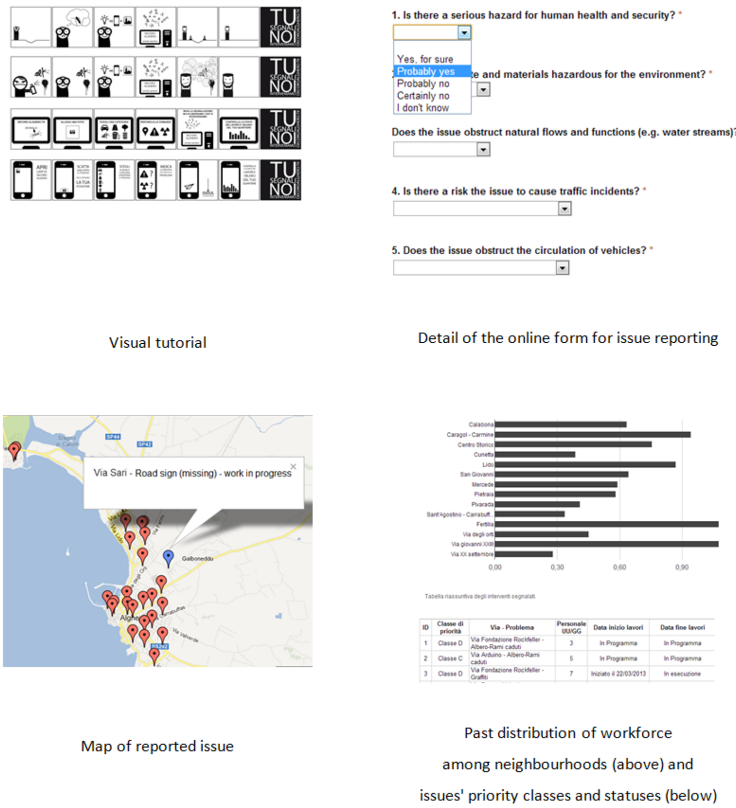
5 THE STANDARD WORKFLOW OF THE SYSTEM

The standard workflow around an issue is made of the following five steps: (1) citizen's report of the issue, (2) data validation by a back-office operator, (3) issue evaluation and rating of priority, (4) allocation of resources and workforce, (5) issue tracking. In Fig. 1 below we show a sample of front-end interfaces and in Fig. 2. a detail of the back-office issues management control panel.

Citizen's report. Through an online form (cfr. top-right in Fig. 1), citizens can report the location and the type of the issue, provide a description and upload photos. The types of issues currently contemplated in the online form are: waste (uncollected or damaged waste containers, littering, unauthorised dumps, abandoned vehicles), infrastructures (water and sewage pipes damage or leaks), transportation (unauthorised parking, damaged, incorrect or missing signs and traffic lights), maintenance (fallen branches and trees, damaged flowerbeds, damaged roads and footpaths), acts of vandalism (graffiti, unauthorised billposting), environment (pollution, request for disinfestations, bad smells, stray animals).

Data validation by back-office operators. As just said, all reported issues have to be assessed by operators before being processed by the evaluation model. Operators can check if the issue has already been reported, ask for further clarifications and discuss the report with citizens, and if necessary, send out inspectors for direct observation on the field. All this leads to a validated record of the report, which is then made publicly available and rated by the evaluation model. (cfr. below-left and below-right in Fig. 1).

Issue evaluation and rating of priority. Based on the information provided by citizens and validated by operators, the evaluation model assigns a priority rating to each issue, following the evaluation procedure described below in Section 4. Again, once attributed, the priority class of each issue is made publicly visible (cfr. below-right in Fig. 1).



Visual tutorial

Detail of the online form for issue reporting

Map of reported issue

Past distribution of workforce among neighbourhoods (above) and issues' priority classes and statuses (below)

Fig. 1 Samples of the public web front-end

ID	Via + Intervento	Quartiere	UU/GG A	UU/GG in esecuzione	UU/GG classi A e B	CLASSE DI APPARTENEZA B	Domanda UU/GG Offerta UU/GG C	In esecuzione D	Eseguito
1	Via Fondazione Rockfeller - Albero-Rami caduti	Via Giovanni XX	3	0		Classe D	1,13		No
2	Via Arduino - Albero-Rami caduti	Centro Storico	5	0	0	Classe C	0,76	No	No
3	Via Fondazione Rockfeller - Graffiti	Via Giovanni XXIII	7	7	0	Classe D	1,13	Si	No
4	Via Roma - Veicolo abbandonato	Centro Storico	1	0	0	Classe C	0,76	No	Si
5	Via Antonio de Curtis - Veicolo abbandonato	Via XX Settembre	2	2	0	Classe C	0,28	Si	No
6	Via Fabra Pompeu - Discarica abusiva	Lido	6	0	6	Classe B	0,87	No	No
7	Via XX Settembre - Tombino (Perdita)	Via XX Settembre	10	10	10	Classe B	0,28	Si	No
8	Via Pietro Nenni - Albero-Rami caduti	Calabona	3	3	0	Classe C	0,63	Si	Si
9	Via Fiume - Tombino (Perdita)	Carmine	10	10	10	Classe B	0,94	Si	No
10	Via Mozart - Strada sporca	Cunetta	5	5	5	Classe B	0,39	Si	No
11	Via Pola - Disinfestazione	Fertilia	4	4	0	Classe C	1,16	Si	No
12	Via Malta - Segnaletica (Errata)	Lido	2	0	0	Classe C	0,87	No	validation l'intervento
13	Via Lo Frasso - Parcheggi abusivi frequenti	Mercede	1	1	1	Classe B	0,59	Si	
14	Via Lo Frasso - Parcheggi abusivi frequenti	Mercede	1	1	1	Classe B	0,59	Si	Si
15	Via Napoli - Graffiti	Pietraia	4	4	0	Classe C	0,58	Si	No
16	Via Catalogna - Strada dissestata	Pivarada	20	20	20	Classe B	0,41	Si	No
17	Via Don Luigi Sturzo - Impianto semaforico non funzionante	Sant'Agostino	7	0	0	Classe C	0,34	No	No
18	Via Enrico Costa - Affissioni abusive	Via degli Orti	5	0	0	Classe C	0,45	No	No
19	Via Caprera Atti vandalici	Lido	40	40	40	Classe B	0,87	Si	No
20	Via Macciotta - Discarica abusiva	Via XX Settembre	25	25	25	Classe A	0,28	Si	No
21	Via Sari - Segnaletica (Mancante)	Carmine	25	25	25	Classe B	0,94	Si	No
22	Via Ospedale - Edificio fatiscente	Centro Storico	30	30	30	Classe B	0,76	Si	No
23	Via fratelli Cervi - Tombino (Perdita)	San Giovanni	5	5	5	Classe B	0,64	Si	Si
24	Via Carrabufas - Discarica abusiva	Sant'Agostino	10	10	10	Classe A	0,34	Si	No
25	Via Corso - Inquinamento	Calabona	22	22	22	Classe A	0,63	Si	No
26	Via Pisa - Marciapiede danneggiato	Pietraia	20	20	20	Classe B	0,58	Si	No
27	Via Pola - Discarica abusiva	Fertilia	10	10	10	Classe A	1,16	Si	No

Fig. 2 A detail of the back-office control panel: the workforce (in man-day) assigned to resolving issues in column A, priority class in column B, workforce demand/supply for issues' neighbourhood in column C, status flags in columns D

6 IMPLEMENTATION

The Web application for the city of Alghero (Italy) was entirely developed using Google cloud services. The application operates around a core developed using the Google Spreadsheet (GS) App service. It is used for data storage, processing, and back-office user interface for the operators of the city maintenance service.

The front-end was developed using Google's blogging and content management service Blogger, integrating Google Maps for mapping and Google Forms (which are natively designed to feed data into the GS App) for collecting issues from citizens. For live data presentation on the front-end in tabular form we use direct frame embedding from Spreadsheet, and Google Charts for interactive charts and more advanced data visualisation.

The business logic, data processing algorithms and back-office user interfaces were developed with Google Apps Script (GAS), which is Google's cloud-centred scripting language based on JavaScript. The main feature of this scripting framework is that, instead of running on the client's browser, it is executed server-side in the Google cloud. One important advantage of the GAS for the purpose of integration and data exchange among Google's and possibly even some third-party services is that it abstracts the underlying low-level AJAX/HTML coding. This comprises the direct access to Google Web Toolkit (GWT) for easier, more abstract and cross-browser compatible development of user interfaces.

The main components, information flows and point of contact among the components and service are shown in Fig. 3.

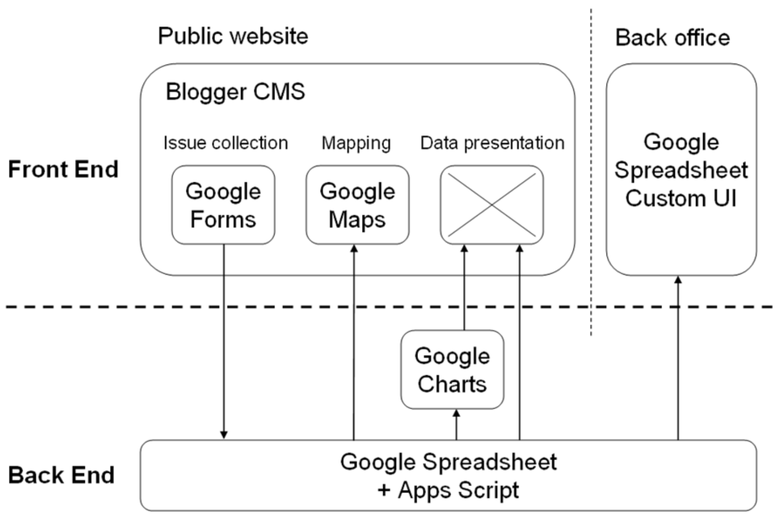


Fig. 3 Scheme of main components, information flows and points of contact among the components and services

Following the standard workflow described above in Section 3., citizens access the website and submit issues via an embedded Google Forms widget. The submitted information gets stored in a GS spreadsheet. All the submitted issues are at first flagged as "new" on the spreadsheet. After the off-line validation procedure, the back-office can override the citizen-submitted attributes and thus put the issue in the "validated" status. At that point the issue gets automatically evaluated by the software and a rating of priority attached to it. The rating algorithm, following the evaluation model specified above in Section 4., operates combining several *ad hoc* developed Google Apps scripting methods and the GS native data processing and calculation capabilities.

Once rated, the operators can insert the resources allocated on the issue, set the start date, and subsequently update the issue status and end date.
Several further related GS spreadsheets are dedicated to data processing and presentation of the detailed and aggregate data in tabular format for embedding in the front-end website and for visualisation by Google Charts services.
We see few disadvantages of choosing this Google-centric approach, using standard low-cost Google cloud services and development tools. Certainly, there are limitations on the scalability. There are for example limits on the GS record numbers and the GAS does not at the time of this writing contemplate connections to internal corporate databases.
However, there are also clear and important advantages: low deployment and hosting costs and practically no systems administration costs, a highly replicable and transferrable solution, and a rapid development process relying on robust Google services. While similar application for a very large city may require to consider alternative set of development and deployment technologies and infrastructures, it may be a sweet spot for small to mid-sized municipalities.

7 IMPLICATIONS ON PARTICIPATION AND PUBLIC POLICY

We presented a concrete proposal of a system for citizens' reporting, evaluation and management of issues for urban maintenance. It is important to place this tool within the complicated and interesting debate on public participation (Irvin and Stansbury 2004), even more so if we think about the so-called e-participation (Coleman 2007; Charalabidis *et al.* 2009; Castells 2012).
One starting point in this discussion is the much cited quote by Sherry Arnstein (1969): «[Participation] is the redistribution of power that enables the have-not citizens, presently excluded from the political and economic processes, to be deliberately included in the future. It is the strategy by which the have-nots join in determining how information is shared, goals and policies are set, tax resources are allocated, programs are operated, and benefits like contracts and patronage are parceled out. In short, it is the means by which they can induce significant social reform which enables them to share in the benefits of the affluent society.»

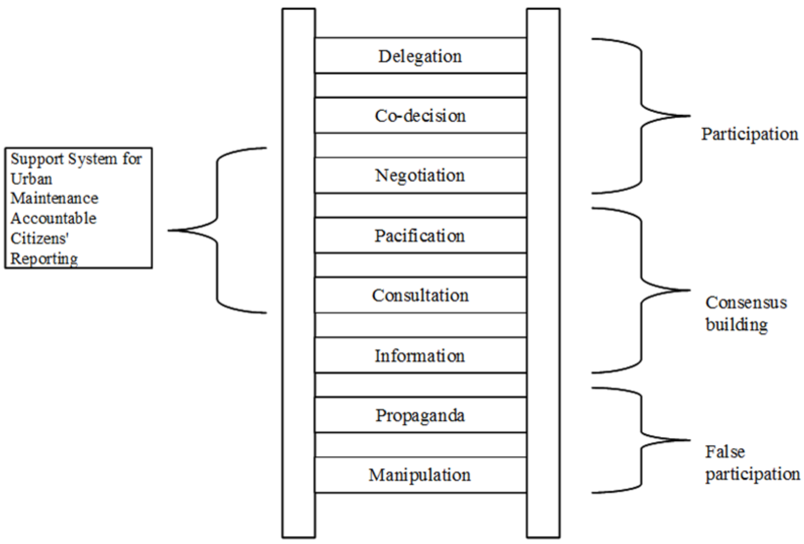


Fig. 4 Arnstein's ladder of citizen participation revisited (Cecchini 2010)

In that paper Arnstein proposed the by now renowned ladder of citizen participation, so many times debated and revisited (Connor 2007; Wiedemann and Femers 1993; Dorcey et al. 1994; Pretty 1995; Rocha 1997).

Following Cecchini (2010), we will also use a ladder, slightly revisited from the Arnstein's original. In Fig. 4, we have placed our system in an area between consensus building and participation. In fact, a fundamental feature of the system, we hold, is its adherence to the principles of accountability and publicity, which makes the citizens' reporting of issues not only consultation and pacification, but also – indirectly and directly – a negotiation. It would not be difficult to think of possible developments to also have, in specific situations, forms of co-decision.

A crucial question, also in this case, is how to develop a communication strategy for effective involvement of all citizens. Our system makes an attempt in that direction, even if questions remain of what to do about those who do not participate, how to involve the Arnstein's "have-nots" in the democratic process, and which strategies to devise to reach them.

There are three groups of people in general who don't participate. Those how do not show interest, do not feel like participating, do not have the necessary capacities nor tools (among whom we find Arnstein's "have-nots" citizens). Then, there are those who hold that the "system" doesn't deserve people's involvement and that the only right way to fight it is to "stay out" of it. Third, there are those who don't participate because they have no interest to make decision-making mechanisms more transparent and accountable, quite the opposite, their true interests would not be safeguarded in democratic processes.

Precisely for it doesn't require adhesions and commitments to predefined and pre-charted processes, the mechanism we proposed in this paper may be useful in involving some from the first and the second group. There remains the problem of how to kindle and support the participation of the first group, those who don't have the necessary tools nor capabilities, yet may have a deep knowledge of the territory.

But this isn't something impossible to come about with something about.

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WALKABILITY EXPLORER.

AN EVALUATION AND DESIGN SUPPORT TOOL FOR WALKABILITY

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ABSTRACT

Walkability Explorer is a software tool for the evaluation of urban walkability which, we argue, is an important aspect of the quality of life in cities. Many conventional approaches to the assessment of quality of life measure the distribution, density and distances of different opportunities in space. But distance is not all there is. To reason in terms of urban capabilities of people we should also take into account the quality of pedestrian accessibility and of urban opportunities offered by the city. The software tool we present in this paper is an user-friendly implementation of such an evaluation approach to walkability. It includes several GIS and analysis features, and is interoperable with other standard GIS and data-analysis tools.

KEYWORDS

Walkability, Evaluation, Decision support, GIS, ELECTRE TRI

1 INTRODUCTION

In this paper we present Walkability Explorer, a software tool for the evaluation of urban walkability.

Walkability of places is an important aspect of the quality of life in cities. Making cities more walkable does not merely improve the accessibility of places, it also is beneficial to the quality of the public use of space and the social climate in general. Ultimately, making places more walkable may expand capabilities of inhabitants, visitors and city-users, especially of those “week population” whose capabilities are curtailed by the predominant motorized practices of the use of space.

We use 'capability' here in specific sense of the so called capability approach (Sen 1993): a person's capabilities are valuable states of being that a person has effective access to. Thus, a capability is the effective freedom of an individual to choose between different things to do or to be that she has reason to value. In this conception, a capability constitutively requires two preconditions: (1) the ability, person’s internal power, detained but not necessarily exercised, to do and to be, and (2) the opportunity, presence of external conditions which make the exercise of that power possible. A person is thus capable, has the capability to do or to be something, only if both conditions – internal and external, ability and opportunity – allow her to. The physical urban space – the city’s hardware – influences capabilities primarily through the channel of the opportunity component of capabilities.

Many conventional approaches to the assessment of quality of life usually measure the distribution, density and distances of different opportunities in space. But distance is not all there is. If we want to reason in terms of capabilities, we should also take into account the quality of accessibility and the quality of urban opportunities. Besides the mere distance, it matters a great deal if a place can be reached also by foot or by bicycle, if the pedestrian route is pleasant and spatially integrated with the surrounding by good urban design, if it is brimful of urban activities, if it is well maintained and (perceived as) secure, if it is not submissive and surrendering to the car traffic whether by design or by predominant social practices of use of that space. At the same time we need to go beyond the simple presence of urban services, to understand their characteristics, if they are able to serve different categories of individuals, if their relevance is on the neighbourhood, urban or metropolitan/regional level, if there are possibilities of choice between two or more relevant places.

For Walkability Explorer, the software tool which is the focus of this paper, we have developed evaluation approaches which attempt to take into account the aforementioned facets of walkability. The assumption of an accessibility-enhancing perspective requires a very strict integration and collaboration between transportation planning, land-use planning and urban design. Walkability Explorer is therefore a milestone is our ongoing research to build evaluation models and a planning and design support tools that takes into consideration many of these concerns, and focuses on the quality of accessibility as an important factor for the extension of urban capabilities.

2 EVALUATING WALKABILITY

2.1 THE DATA

The evaluation of walkability is based on the exploration of how someone at different points in space can walk to destinations of interest in an urban area. A destination of interest is a place, service or facility which promotes an urban opportunity.

The concept of walkability pinpoints at features beyond the geometry of urban space. Besides mere presence of places of interest and their distances, factors related to the quality of pedestrian routes such as

urban design and quality, track and road conditions, land-use patterns, building accessibility, degree of integration with the surrounding, safety and other features and practices of use of space, are all potentially relevant for walkability.
Therefore, for an operational evaluation of walkability, much richer spatial datasets are required. Our starting point are: (1) a detailed graph representation of the street network and (2) a detailed map of relevant places (destinations).

The street network graph is the cartographic base for the pedestrian route analysis. Besides their geometric properties, the edges hold relevant features for the walkability of a pedestrian route. In Table 1. we report an example list of edge attributes we used in our experimental runs of WE.

URBAN DESIGN	VALUES	DESCRIPTION
Building density	(qualitative) dense – rarefied –undeveloped	Describes the density of the urban fabric surrounding the edge.
Degree of integration	(qualitative) Integrated – filtered – separated	Describes how the pedestrian pathway is integrated with the surrounding buildings and areas. "Integrated" stands for complete integration and permeability; "filtered" means that the access is possible but "filtered" with specific points of access, pathways, etc.; "separated" stands for a complete separation (e.g. a wall or fence).
Street type	access – residential – crossing/bypass	The predominant type of the street: "access" to services, shops, offices, etc.; "residential"; or a "crossing/bypass"
Physical features		
Bicycle track	present – absent	
Number of car lanes	(number)	
Car speed limit (in km/h)	(number)	
One-way street	yes – no	
Car parking along the road	not allowed/practiced – allowed/practiced	Whether cars are parked/allowed to park along the motor lane
Footway width (in meters)	(number)	
Degree of maintenance	(qualitative) good – average – bad	A qualitative evaluation of the degree of maintenance (footpath, illumination, trash bins, flowerbeds, etc.)
Land-use pattern		
Commercial activities	(qualitative) predominant – present – absent	Whether commercial activities (shops, bars, restaurants, etc.) are predominant, present or absent
Services and offices	(qualitative) predominant – present – absent	Whether services, businesses and offices are predominant, present or absent

Tab.1 Example of edge attributes

This, of course, is only an example and far from a complete list. Many other attributes could be useful to assess walkability, and we are surely failing to account for important aspects such as practices of use of space, social climate, perception of personal security, and many more. WE is a flexible tool and can import any set of attributes which scholars and users may consider of relevance for the evaluation of walkability in accordance to particular normative assumptions, empirical findings and available data.

The map of relevant places describes the spatial distribution of places, services and facilities and represent the information base for the analysis of particular attributes determinant for the promotion of urban opportunities. These attributes may in principle describe the quality of places, design of space, capacity to attract different categories of peoples at different times of the day, capacity to favour different uses in the space (play, meetings, study, ...), and other features important for the accessibility of the space, intended as the possibility of appropriation of the urban space in respect to human needs. For the example runs of WE, we have classified destinations of interest in three categories: commercial (shops, bars, restaurants, etc.), services (schools, health services, libraries, etc.) and recreational and leisure areas (green areas, urban parks, sport facilities open to public). In Fig. 1 we show a screen capture of the maps with these three types of destinations.

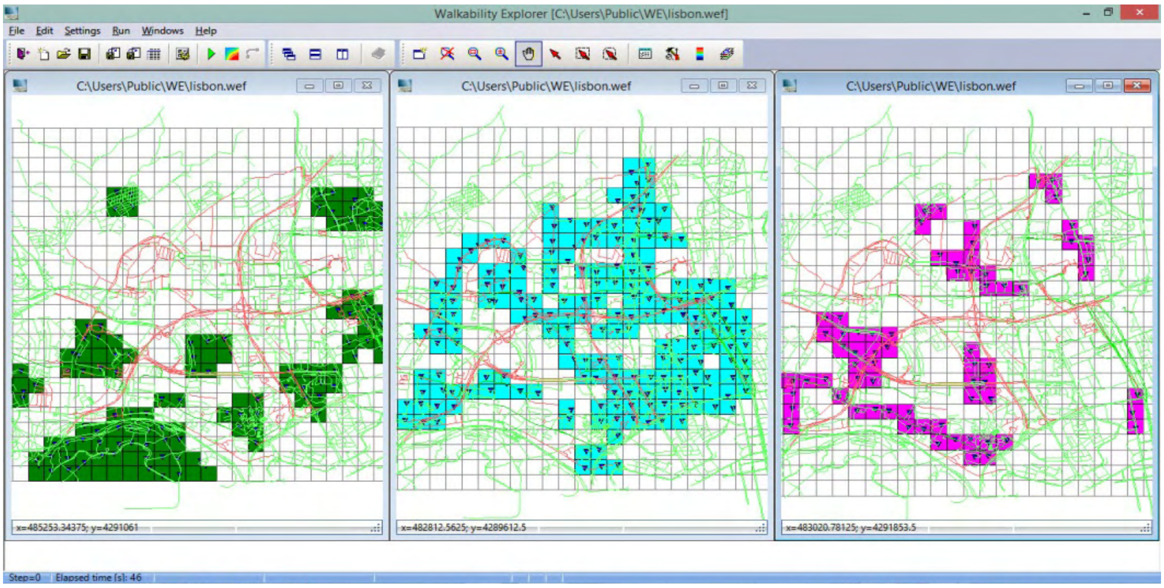

Fig. 1 A screen capture of WE representing the destination cells for different type of attractions and the destination node for each cell

2.2 EVALUATION MODELS

In the following we propose two different models for evaluating and comparing the pedestrian routes along a street network, considering their quality and walkability (Livi *et al.*, 2004) and the quality of urban opportunities.

– The first model aims to evaluate the walkability by the analysis of pseudo-utilities. For each category of destinations, we define the pedestrian behaviour as an utility maximisation problem given the distance and the quality of pedestrian accessibility of destination places belonging to that category.
– The second aims to assign an opportunity rating to each point in space. For each category of destinations, we define the pedestrian behaviour as a pedestrian class maximization problem given the distance, the quality of pedestrian accessibility of destinations belonging to that category and the quality of destination places.

2.2.1 WALKABILITY AS A PSEUDO-UTILITY

We assume that a resident living at one point in space will walk to available destinations a certain amount of times, and will from that derive utility defined by the following constant elasticity of substitution (CES) function:

$$U = \left(\sum_{i=1}^{n} X_i^{\rho} \right)^{\frac{1}{\rho}} \qquad (1)$$

where *n* is the number of available destinations, X_i is the number of times the resident visits the *i-th* destination and *1/(1 – ρ)* is the elasticity of substitution among destinations.
The constraint imposed upon the pedestrian is:

$$\sum_{i=1}^{n} c_i X_i \leq M \qquad (2)$$

where *ci* is the cost the pedestrian foregoes to reach the destination *i*, and *M* is the available budget with a conventional constant value.
A path from an origin to a destination is a set of *n* interconnected edges. Besides sole distances, we describe edges on further attributes which shape the quality of the pedestrian accessibility, characteristics such as physical features, urban design, presence (or absence) of variety of urban activities. These attributes serve to model the cost of a path used in the constraint expression (2). We define the cost of a path of *p* edges as:

$$c = c_0 + \sum_{k=1}^{p} l_k \left(1 - \left(\sum_{l=1}^{r} w_l a_{k,l}^{r} \right)^{\frac{1}{r}} \right) \qquad (3)$$

where c0 is the fixed cost, l_k is the length of the *k*-th edge in the path, $a_{k,l} \in [0,1\rangle$ is the value of that edge's *l-th* attribute, w_l is the weight of the attribute $(\Sigma w_l = 1)$, and *r* is a parameter with *1/(1 – r)* being the elasticity of substitution among attributes. This expression yields unit variable cost of 1 when all attributes are at their lowest value (i.e. 0) , and approaches 0 when attributes approach the highest value of 1.
Among many alternative paths from an origin to a destination in a street network, we plug the cheapest one into the expression (2).
Under the constraint (2), the utility in expression (1) is maximised when:

$$X_i = \frac{c_i^{\frac{1}{\rho-1}} M}{\sum_{j=1}^{n} c_j^{\frac{\rho}{\rho-1}}} \qquad (4)$$

2.2.2 A NESTED ELECTRE TRI FOR OPPORTUNITY RATING

Here we concentrate to describe an alternative model based on the ELECTRE TRI rating procedure. In particular, for the purpose of rating urban opportunities we adapted the ELECTRE TRI approach in a particular nested procedure.
The aim of the evaluation model is to assign an “opportunity rating” to each point in space, that is to say, to put it in one among several classes of urban opportunity (one class for each among different types of urban opportunities). The core idea of the evaluation approach we propose is based on nesting several ELECTRE

TRI evaluation procedures, one within another. So before laying down our "nested" model, let us briefly recall the basic general ELECTRE TRI model.

Among the methods for multiple criteria evaluation of ratings (Bouyssou *et al.* 2006) , the so called ELECTRE TRI model (Yu 1992; Roy *et al.* 1993) is a prominent classification approach. This rating approach possesses several desirable properties for our purposes: (1) it allows a complete classification, and the aggregation over multiple criteria is fairly flexible, permitting to account for (2) the importance (weights) of criteria, (3) coalitions (majority rule and threshold) and (4) possible veto powers. Besides, as it will be shown, out nesting ELECTRE TRI procedure allows a careful aggregation over criteria at each level of nesting in a controllable and meaningful way more in accordance with "natural" human reasoning.

The general ELECTRE TRI procedure works as follows. Given a set of objects, evaluated on a set of criteria $h_1 \dots h_n$, to be assigned a rating class from a set of classes with ordinal property $C^1 \dots C^m$, ELECTRE TRI first requires that the so called limiting profiles be defined for each class. That is to say, each class C^k is defined by a limiting profile π^k on m criteria: $\pi^k = \left(\pi_1^k, \dots, \pi_n^k\right)$. To respect the ordinality of classes, the limiting profiles should be defined so that $\pi_i^k < \pi_i^{k+1}$ for every $i=1,\dots,n$.

To assign an object a to a rating class we then apply the following two rules (Bouyssou *et al*, 2006):

– if the object *a* has the same or higher evaluation on the *m* criteria than π^k, it should at least belong to the class C^k;
– if π^{k+1} has the same or higher evaluation on the m criteria than the object *a*, then it should at most belong to class C^k.

Formally:

$$a \in C^k \Leftrightarrow a\,P\,\pi^k \wedge \pi^{k+1}\,P\,a \qquad (5)$$

where *P* is the binary outranking relation meaning "belongs to the same or a higher class than".

The binary outranking relation *P* uses a crisp relation based on a concordance-discordance principle, that is to say, an object *a* outranks a limiting profile π^k if there is a "significant" coalition of criteria for which "*a* belongs to the same or higher class than π^k" (concordance principle) and there are no "significant opposition" against this proposition (discordance principle). In other words:

$$a\,P\pi^k \Leftrightarrow C\left(a,\pi^k\right) \wedge \neg D\left(a,\pi^k\right) \qquad (6)$$

where:

– C(a, πk) means there is a majority of criteria supporting the proposition that a outranks ("is at least as good as") πk;
– D(a, πk) means there is a strong opposition, that is to say a veto, to the proposition that a outranks ("is at least as good as") πk.

Following Roy (1968), for two evaluation profiles *x* and *y*, we use the following definitions of *C(x, y)* and *D(x, y)*:

$$C(x,y) \Leftrightarrow \frac{\sum_{i \in H(x,y)} w_i}{\sum_{j=1}^{n} w_j} \geq \gamma \qquad (7)$$

$$D(x,y) \Leftrightarrow \exists h_i : h_i(y) - h_i(x) > v_i \qquad (8)$$

where:

– h_i , $i = 1,\dots,n$ are the criteria (the higher the value the higher the class);

– w_i are the importance coefficients (weights) associated to each criterion;
– $h_i(x)$ is the evaluation of x on the criterion h_i;
– $H(x,y)$ is the set of criteria for which x has the same or higher evaluation than y, that is, for which $h_i(x) \geq h_i(y)$;
– γ is the majority threshold;
– v_i is the veto threshold on criterion h_i.

After this recall of the basic ELECTRE TRI rating procedure, let us now lay down the specific nested procedure which we have developed for evaluating urban opportunities in space.

Let we define a set of ordinal opportunity classes from lowest to highest, $O^1 \ldots O^m$. Again, our objective is to assign to each point in space one and only one class by taking into consideration both (1) the quality and (2) the accessibility of destinations of interest from that point.

Each destinations may fall into one or more types of urban opportunity (e.g. green areas, retail, services, etc.). To represent this fact, each destination d is evaluated in terms of "quality" per each type of opportunity, which we will denote with $q_l(d)$, where l stands for the type of opportunity.

To evaluate the accessibility, we use a detailed graph representation of the street network. A path from an origin to a destination is a set of interconnected edges. Besides their length, edges are described with further attributes which shape the quality of pedestrian accessibility, with characteristics such as physical features, urban design, presence (or absence) of variety of urban activities, and so on (see Table 1. above for a example of edge attributes). Hence, in general terms, for every edge i in a path from one point in space to one destination, we have the edge's length l and a set of attributes $a_1, \ldots a_p$ which describe its characteristics.

Given such a configuration of definitions and available data, the "nested ELECTRE TRI" procedure we propose proceeds in four steps:

– Step 1: Assign a walkability class to each edge in the path;
– Step 2: Aggregate the walkability of edges in the path (from Step 1) to assign an overall walkability class to the entire path;
– Step 3: Combine the walkability class of the path (from Step 2) with its length to assign an accessibility class to the couple origin-destination
– Step 4: Combine the accessibility of all the destinations (of one type of urban opportunities) reachable from an origin, to assign an urban opportunity score/class to that origin (for that type of urban opportunities)

Step 1. Edge walkability rating. In this step we use ELETRE TRI to assign a walkability rating to each edge, using edge attributes as criteria. The step further requires that a corresponding set of criteria weights, possible veto thresholds, and the majority threshold be defined.

Step 2. Path walkability rating. Here, the ELECTRE TRI serves to assign a *walkability rating to the entire path*, by using the edges themselves as criteria. Their walkability classes (obtained in the Step 1) are used as criteria values, while their lengths are used as weights. So, this step only requires the definition of the majority threshold and possible vetos.

Step 3. Accessibility rating of each couple origin-destination. We now need to evaluate the overall *accessibility* of the destination from the origin. The accessibility should take into account both the quality of walk, i.e. walkability, and the distance. Therefore, for this purpose we again employ ELECTRE TRI, this time using two criteria: the walkability of the path (obtained in the Step 2) and its length. This step therefore requires to further settle the respective weights of the two criteria, as well as the majority and possible veto thresholds.

Step 4. Urban opportunity scores/rating. This is the final phase in which we assign the final urban opportunity ratings to the origin point in space. It combines the information about the quality of the destinations which are reachable from that origin with their accessibility rating (obtained in the Step 3). Therefore, this step may be performed only after all the accessibility ratings have been assigned to every couple origin-destination. Also, since different destinations are, as we said, relevant for different types of urban opportunity, we proceed separately and independently, calculating an opportunity score per each type of opportunity. The opportunity score of an origin *U(o)* is obtained with:

$$U(o) = \sum_{i \in D} q(d_i) a(o, d_i) \qquad (1)$$

– where D is the set of reachable destination relevant for the type of opportunity under assessment;
– $q(d_i)$ is the quality score of the destination i;
– $a(o,d_i)$ is the accessibility score of the destination i from the origin o; the accessibility scores are accessibility ratings (obtained in Step 3.) transformed into numeric factors [0,1].

In the end, having calculated the urban opportunity scores for each type of opportunity, the final urban opportunity ratings are assigned by defining fuzzy thresholds on scores per each different type of urban opportunity.

3 A GENERAL OVERVIEW OF WALKABILITY EXPLORER

We are currently working on fully implementing the two evaluation models in Walkability Explorer (WE).
WE is an application running on Microsoft Windows whose user interface allows an easy assessment of the walkability. It furthermore allows a comparison in terms of walkability between the current situation and hypothetical projects concerning features relevant for the walkability, in terms of the evaluation model described above.
In Fig. 2 we show the standard workflow to perform a walkability evaluation in We.
First, the user is asked to provide the road networks in the format defined by the Open Street Map (OSM) project (see screen capture in Fig. 3) OSM is a collaborative project for the creation of street maps that currently makes available a huge data base covering most part of the world. In addition to the availability of street network data, the advantage of using OSM for this application lies in the ease of introducing new attributes and topological changes that affect the graphs. For this purpose there are indeed several effective editing applications freely available. If the purpose is to compare the current situation with a future project, a further road network with the features modified by the project has to be provided.

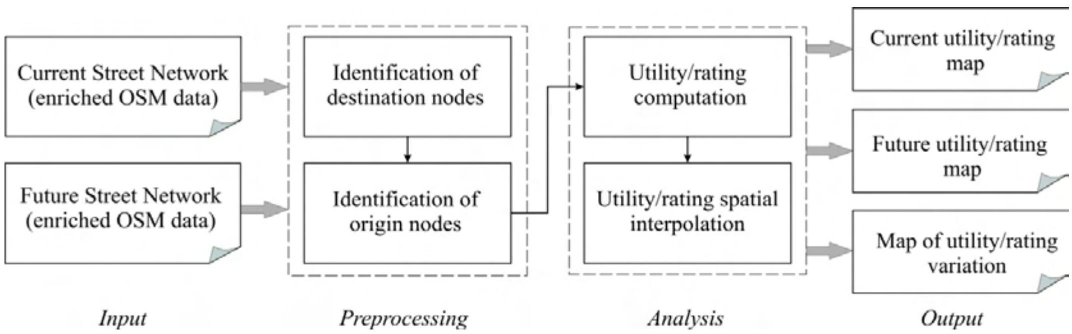

Fig. 1 The typical WE workflow. The required input data are the current and future street network in OSM with graph edges enriched with attributes relevant to the walkability (e.g. Tab. 1). After the preprocessing and analysis phases, the main output is represented by the utility-score maps (if using the pseudo-utility evaluation model) or ratings (if using nested ELECTRE TRI procedure) at the desired resolution

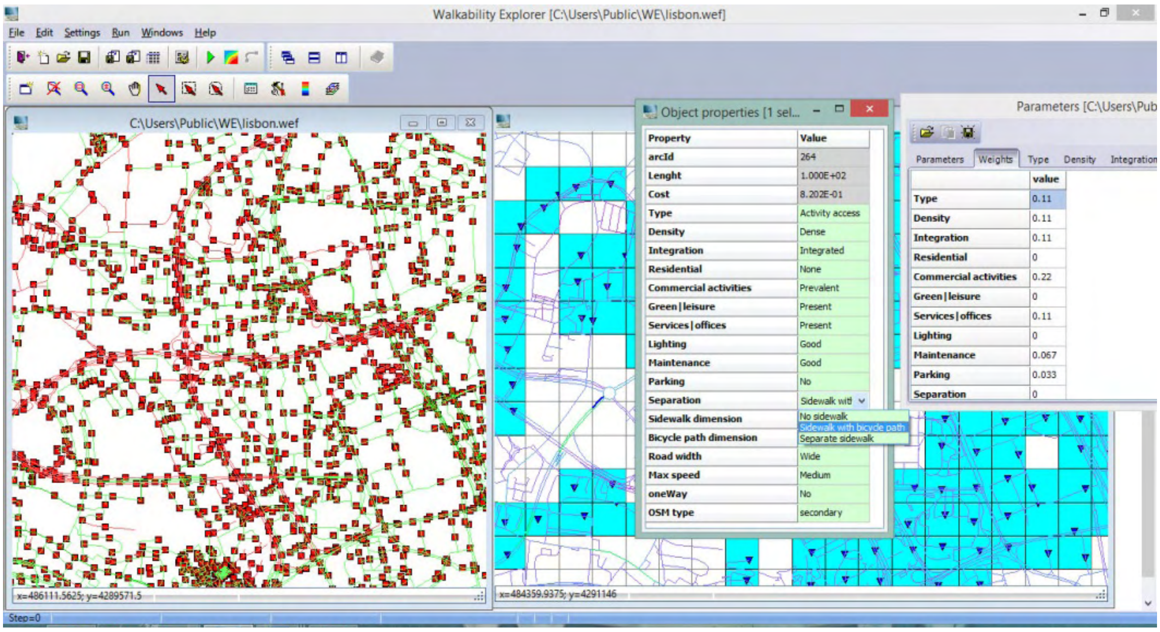

Fig. 3 A screen capture of WE representing the street network with the visualization of the edge parameters and an object property

Given the OSM data enriched with the set of edge attributes, the program identifies the areas of attractions using a regular grid of cells, according to a resolution set by the user, and constructs the sets of destination nodes (for an example see Fig. 1 above).

It is worth noting that the size of cells can be set independently for the different types of attractions. In particular, WE identifies the areas with prevalence of retail/commercial and service activities using the specific attributes attached to the edges in the OSM data. For the green/recreational attractions, the current implementation of WE exploits the polygons representing such urban areas, which are typically included in the OSM data. The program builds the set of destination nodes by finding for each attractive cell the node of the street network which is closer to its centroid (Fig. 4).

WE determines the origin nodes for both the current and future street network. It is worth noting that, to increase the comparability of results, during the filtering process the program tries to make sure that the origin nodes of current and future road networks coincide. This is not possible in areas where there are geometrical and topological changes of the network.

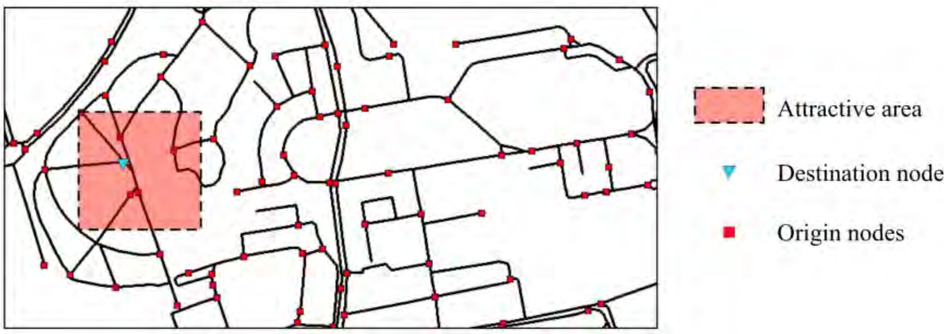

Fig 4 Origin nodes, attractive area and the corresponding destination node

The analysis run allows to calculate the utility-scores (if using the evaluation mod-el based on pseudo-utility functions) or ratings (if using nested ELECTRE TRI procedure). The computation is carried out for the current and the future street network and for the each types of attraction. In order to shorten the run-time, WE exploits the available multi-core CPU computers implementing a parallel multi-thread approach.

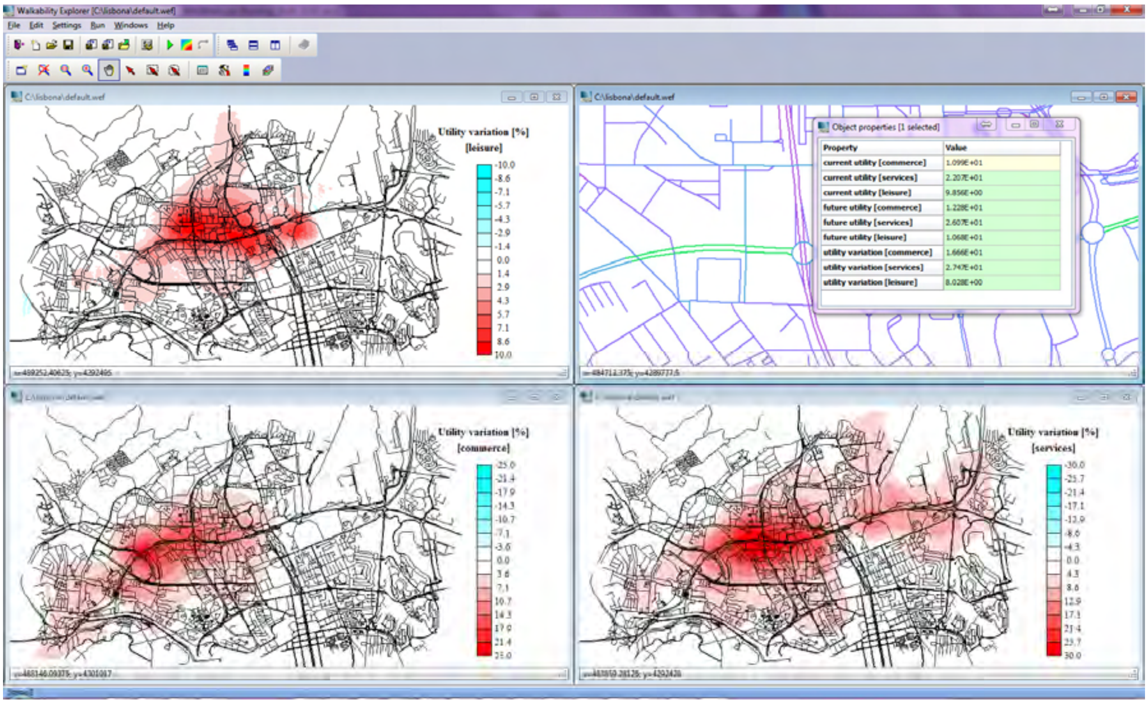

Fig. 5 A screen capture of WE representing georeferenced pseudo-utility maps for different types of attractions

The final output of the program are the georeferenced utility-score maps (e.g. Fig. 5) or ratings for both the current and future street networks and for all the types of attractions. Moreover, WE provides the map of utility/rating variation due to the project. All the above maps can be exported in a suitable GIS format for further elaborations.

The processing described above require to extensively operate with geo-referenced data, as well as the possibility to efficiently perform spatial queries. For this reason, the program has been implemented using the C++ MAGI library (Blecic *et al.* 2009; Blecic *et al.* 2009), which makes available the necessary functions of spatial indexing.

Besides producing georeferenced maps, WE allows the results to be exported in the open csv format for further analysis in other GIS and statistical analysis tools. One such possible analysis is to calculate indicators for comparing the aggregate variation of walkability between alternative scenarios as well as its spatial distribution and dispersion in relation to the populations inhabiting the urban area under consideration.

4 CONCLUSIONS

Capability approach coupled with the analysis of accessibility provides a compelling theoretical framework for assessing relevant aspects of the quality of life in cities. The space and urban environment are important constituent of certain human capabilities and are determinant for the individual life in cities. Among other dimensions of individual wellbeing (health, education, political participation, and so on), the way our cities and physical environment 'functions' – the way they are shaped, organized, and used by social practices – matters.

Architects, urban planners and policies makers could use urban capabilities to read and interpret the multiple relations between the individual and the city, to unveil the circumstances in which the city is an 'obstacle' to the needs and aspirations of its inhabitants, to better define and govern urban design processes which aim at removing these obstacles, to promote the right to the city (Lefebvre 1978; Harvey 2009; Soja 2010) for all.

Such design attitude requires tools. Walkability Explorer is an attempt to implement evaluation models and to provide an user-friendly tool for assessing walkability which may prove useful for improving effectiveness, relevance, and inclusiveness of urban design and transport planning.

There is further work to be done and there are many areas in which we plan to extend WE's features. Foremost, to become a more complete decision support for assessing urban capabilities, besides walkability it should also be able to take into account the car and public transportation accessibility, and the way they interact with the pedestrian accessibility. Such incorporation of non-pedestrian mobility into WE would be an indispensable step to also take into account the quality of accessibility of not only neighbourhood-level destinations, but also those on the urban and metropolitan/regional level, which of course also play a relevant role in shaping overall urban capabilities of people.

We intend to pursue these objectives in our future work.

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Fig. 1, 2, 3, 4, 5: personal elaboration.

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DIACHRONIC ANALYSIS OF PARKING USAGE

THE CASE STUDY OF BRESCIA

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ABSTRACT

The paper proposes a methodology for the investigation of the space-time relations between public services and individual mobility, by checking the space-time efficiency of the allocation of public and private parking areas. The methodology has been applied to the case study of Brescia, in northern Italy. The spatial distribution of car parking has been assessed as well as the usage variations during the day.

First of all, the location and the density of parking areas within the city has been taken into account, and represented to show the spatial coverage of car parking supply. Then, the temporal issue has been considered, since the degree of use of each parking area varies within the time of the day. Therefore, the degree of use of each parking area has been mapped at three significant instant of the day (10.00 a.m.; 01.00 p.m. and 04.00 p.m.). This kind of analysis is particularly helpful to highlight the availability of parking areas during the day. The results of the analysis, even if referred to a case study, can be extended to similar situations as the methodology of the analysis has a broaden sound meaning. The aim of the paper is to illustrate a method to develop mobility policies and plans.

KEYWORDS

Urban and mobility planning; Car parking; Public services; Diachronic accessibility.

1 INTRODUCTION

Aim of the work is to propose a methodology to investigate the space-time relations between public services and individual mobility, checking the space-time efficiency of the allocation of public and private parking areas.
Urban mobility, that is an indispensable form of individual autonomy, most often results in the indiscriminate use of private car (Bertolini and Clercq, 2003), definitely for their comfort as well as they are perceived as a "status symbol". Nevertheless, mobility is a battleground between individual needs and public goods (Tira, 2001). So, urban planning – focused on the resolution of conflicts between private and public -, treats the issue of mobility also in terms of accessibility to (public) services and from the point of view of sustainable development. Mobility policies must include a set of provisions designed to encourage citizens to use alternative transport means (Busi and Tiboni, 2003), instead of cars, in order to decrease the impact to the environment and the economic system.
Accessibility to services is a part of the main objectives of sustainable mobility, that can be achieved both through the best location of public services and the highest possibilities to reach them. If the location can be influenced by the planning policy designed in the Municipal Town Plan (containing, for example, the requirements for the containment of soil consumption and the features to assess the proximity to existing settlements), accessibility should first refer to specific means of transport, designed to reach the service (Bonotti et al., 2012). Therefore, the knowledge of demand and supply of parking areas can be an indirect mean for to know the supply of the available means of transport: the highest being the accessibility by public transport, the least should be the car park filling rate.

2 THE ISSUE OF THE TEMPORAL ANALYSIS OF PARKING LOTS

The demand for parking is not readily measureable. A possible evaluation can be found in the scientific literature (see, i.a., Shoup, 1999; Axhausen, 2007; Roli and Medeghini 2007) with a first detection of the general behaviour of users searching for a free parking lot. The user generally looks for a parking lot very near the destination, focusing his research on a limited number of options - in case he knows the area - also taking into consideration the costs.
In other situations, when the environment is not known, the user prefers to go directly to free or cheap parking areas, although more distant from the destination, unless he needs a quick stop. In that case the user focuses its research in one place immediately next to the destination, accepting the risk of illegal stopping, if there are no other places available.
Shoup (2005) inversely correlates the hourly rate of parked vehicles with the walking path to and from the parked car: the higher is the hourly cost of parking, the lower is the average dwell time and the shorter is the distance walked from car to destination. This theory highlights how user behaviours and his choices follow several variables. For that reason, it is preferable to adopt a direct measure of available and employed parking places to define both the supply and demand for parking.
If the demand of parking plots is easily measured through the amount of cars dwelling on the road or inside parking structures, the supply will be defined as the amount of space devoted to regulated parking.

3 TOOLS AND DATA SETS FOR PARKING ANALYSIS

Some data need to be collected for the application of the accessibility analysis. The required database should contain at least the following informations:

- the geographical informations about the mobility system;
- the car parking filling rate during the day;
- data files of services and facilities (as the main attraction points of the city), both public and of public interest.

The spatial analysis has been be performed in a GIS environment, using geo-referenced informations of the location of car parking areas (the free plots as well as the toll places, both on the road and in parking structures). These data can be obtained from the Municipality and the public transport companies.

The number of parking lots can be obtained from the size of the area, considering an average of 25 square meters each.

To link accessibility and time usage it is necessary to assess the temporal degree of park filling rate, analysing the data from the company that manages the parking fee service. There is usually a large and updated database that includes the location, the availability and the filling rate during each day of the last few years, for each parking structure and parking meters.

Otherwise, the filling rate of free parking areas is almost unknown, or hardly reliable and complete data exist. While spatial and temporal data are necessary for the accessibility analysis related to the whole territory, public service data files are asked for the last step of the assessment that aims at studying the accessibility linked to the opening hours of the services.

Therefore, the geographical location of the services and their opening hours must be known. The data files select qualitative and quantitative parameters, taking into consideration both the boundary conditions (roads, parking capacity, environmental features, etc.), and the characters of the structures (compliance minimum dimensional standards, maintenance and security conditions, minimum support structures, etc.).

As well as quantitative parameters, expeditious indices have been defined to assess the quality degree of environmental parameters.

4 SPATIAL DEVELOPMENT OF THE PARKING SYSTEM IN BRESCIA

The case study of Brescia will be used to test the research method. Brescia is a medium sized city of nearly 190,000 inhabitants and a surrounding metropolitan of around 500,000 dwellers. Since 2013, a new light rail system has entered into operation (Bonotti et al., 2012). Such a big work has immediately reorganized the public transport network and will probably change the private mobility patterns too.

In 1931 Brescia had its first car park structure: a structure made to accommodate 200 cars including a warehouse for spare parts, a repair shop and a point for washing and refuelling cars.

During the sixties, roads were no longer adequate in comparison to the motorisation rate.

In order to find possible solutions to urban congestion of the road system and to promote a more sustainable urban mobility, in 1968 the Municipality of Brescia adopted a strategic plan called "Urban Traffic Plan". The Plan showed that 70% of work trips were made by cars, thus resulting in a high parking demand.

In 1990, the Municipality approved the new Parking Plan, aiming at regulating private mobility in the city centre and creating new parking areas and structures outside the centre, with the objective of removing illegal parking from the streets.

The Plan proposed a graduated cost of parking, to be coordinated with the development the public transport network and the accessibility.

In 1996 the Municipality of Brescia profoundly revised the parking system.

Following the experience of many European cities, particular attention was paid, through urban policies, to the connection between parking and sustainable mobility.

The main policies adopted were:

- different parking solutions for selected users: free parking far away from the city centre and rising costs and decreasing time limits approaching to the centre;
- realisation and extension of a limited traffic zone in the downtown;
- dedicated lanes for buses and taxis.

5 INDIVIDUAL MOTORISED TRANSPORT ACCESSIBILITY TO THE MUNICIPAL AREA

5.1 CAR PARKING SUPPLY AND SPATIAL ACCESSIBILITY

As already mentioned, one factor that certainly influences the choice of parking is related to the distance to be covered on foot from the parked vehicle to the destination and vice-versa: the higher is the dwelling time, the more acceptable will be the length of walking path. Dixon (1996), Miller (2000) and Litman (2011a) highlight the levels of service of urban walkability in relation to the walking distance after leaving the vehicle, depending on the characteristics of the user and the environment.

An analysis of car spatial accessibility has been made with regard to the availability of car parking in Brescia. The parking Plan for the city centre ensures a level of accessibility to any destination from the nearest car park equal to 300 meters. Considering all the municipal surface, all parking areas have been considered accessible if located at a distance (radial) of 350 m, corresponding to the average walkable distance in 5 minutes. The accessibility level is a linear function varying from 1, corresponding to the centre of the parking area, to 0 at the edge of the area of influence. The results are shown in Figure 1.

In Figure 2 each parking area is described by the number of parking lots.

So it is possible to quantify the available parking spaces within a radius of 350 meters from the chosen point. Both analysis took into account the presence of the Limited Traffic Zone (ZTL). Therefore, particular attention should be focused on this area during analysis and considerations.

5.2 FILLING TIME OF A PARKING AREA

How is it possible to link the temporal dimension with the spatial analysis already performed? The car parking is an indirect indicator of the degree of use of services. Despite the fact that the accessibility by private means in Brescia can generally be guaranteed 24 hours a day, the filling rate of the parking lots varies according to the time slot, as well as, in some cases, the opening hours of the car park.

Three thematic maps have been drawn. They focus on three significant time slots during a spare day:

- 10.00 a.m., critical time for toll parking;
- 01.00 p.m., lunch time;
- 4.00 p.m., afternoon rush hour.

In the following map (Figure 3), the degree of use of the toll parking places has been represented by using different colours for each filling rate. The green colour identifies parking lots with more than 75% vacancy, yellow between 75% and 50% vacancy, orange between 51% and 25 % vacancies, red with less than 25% vacancy, and finally black identifies completely filled parking areas.

Figure 3 shows the results for a limited area of downtown Brescia, including the historical centre.

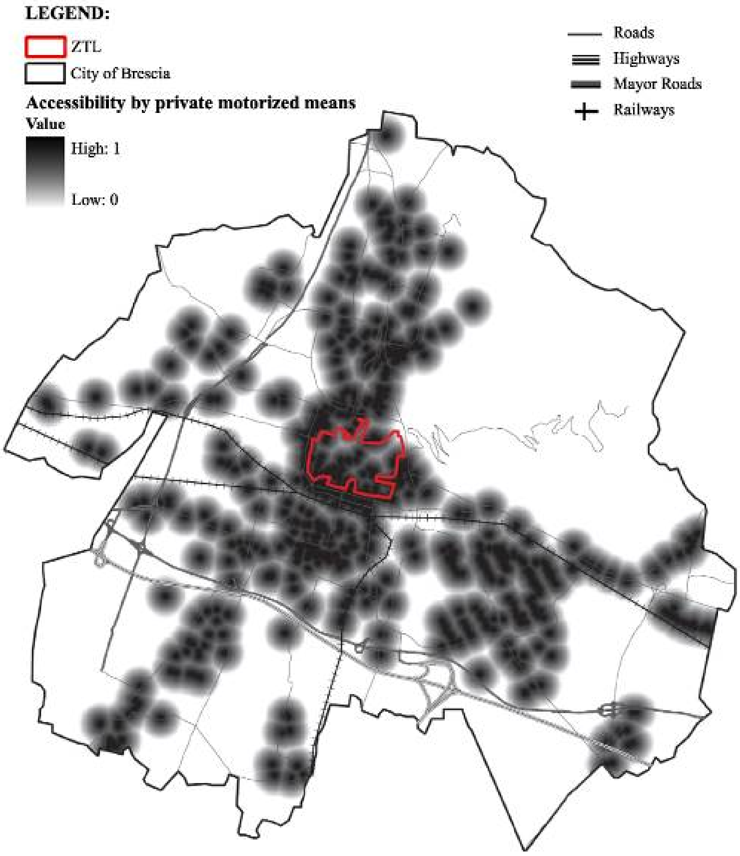

Fig. 1 Brescia and the accessibility rate of cars, described by the grey intensity

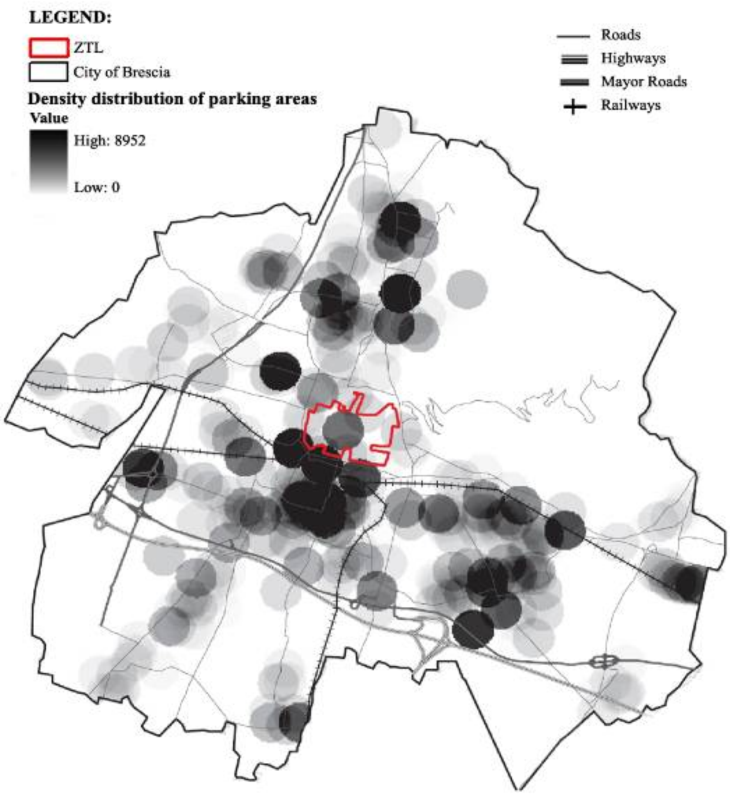

Fig. 2 Brescia and the density of parking spaces

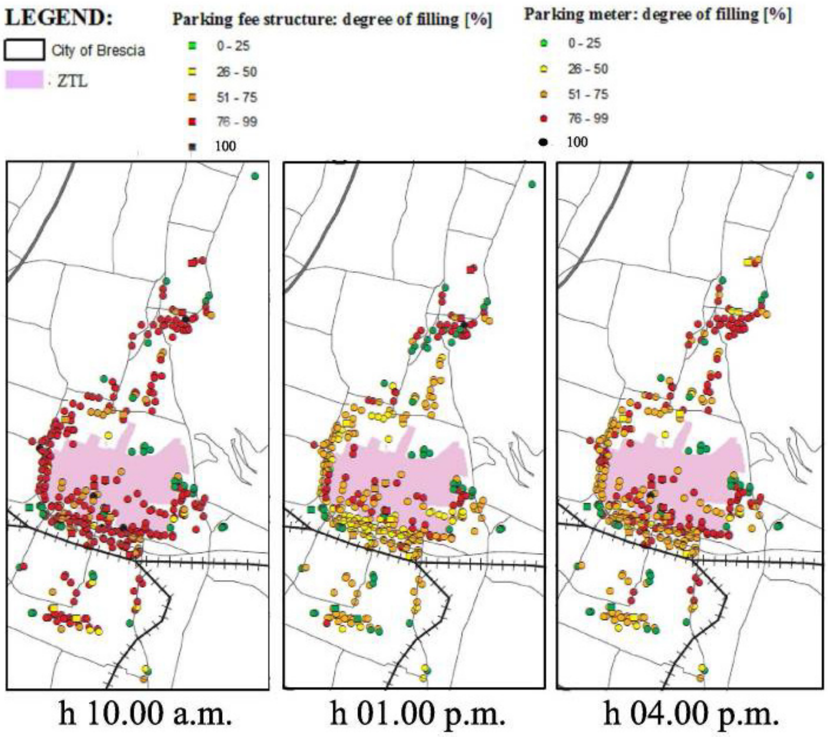

Fig. 3 Degree of use of the toll parking during three particular hours of the day (Data Source: Brescia Mobilità 2010)

5.3 INTERACTIONS BETWEEN CAR USAGE AND SERVICE LOCATION

Finally, according to accessibility theories, the availability of car parking should be linked with the location of the activities and opportunities located on the territory (see, i.a., Hansen, 1956; Litman, 2011b).

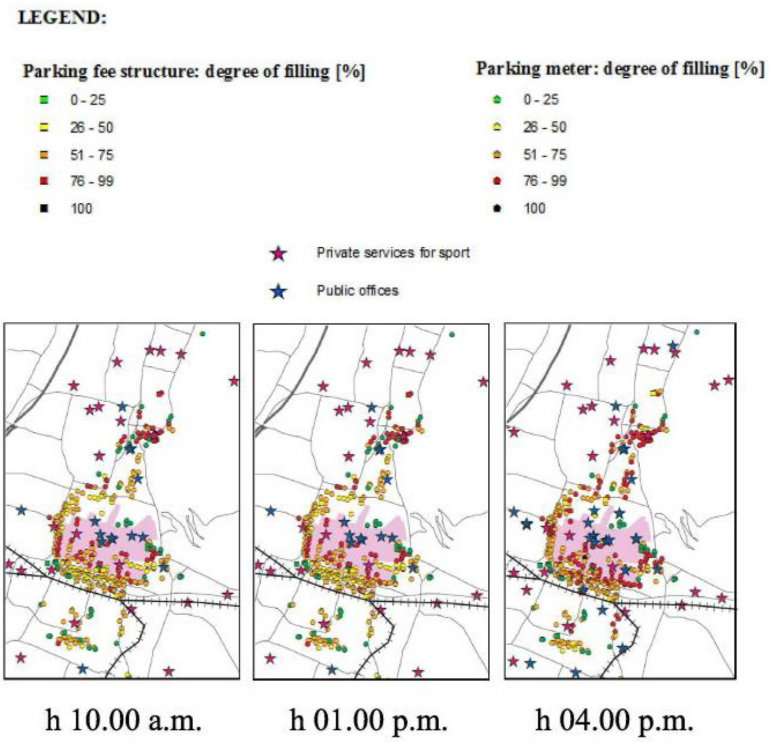

Fig. 4 The relationship between the degree of parking filling in time and public services opened at the same time

Processing available data, it is possible to evaluate the average number of parking lots available for each service and to what extent they are filled during the day. To give an example, this analysis is provided with reference to two kinds of facilities in Brescia: public offices and sport facilities.
Concerning the data available on the location and on the hours of operation for all the services in the municipality, some critical aspects can be highlighted, as some services are opened when the public transport system does not operate, or when number of parking spaces are not able to meet the demand that service requires (figure 4).

6 CONCLUSIONS

There is no doubt that the car has defined a new level of comfort for accessibility, and people expect easy access to city centres, housing and workplaces without long walking distances. Therefore, a fundamental dilemma arises when trying to make urban development less dependent on car: the inability of most alternatives to match the quality of accessibility provided by private motorised transport (Bertolini & Le Clercq, 2003). The assessment of the accessibility level provided by car parking areas and their use is therefore a first step towards the implementation of sustainable mobility policies, aimed at providing competitive alternatives to car use.
Within this framework, the paper showed that the location and the density of parking areas are strictly linked, but the daily use mostly unknown and influenced by the changing opening hours of services.
The results could be used to better place parking places, but also to dismiss them when a public transport means could be an efficient alternative. Also toll system can be assessed through the analysis, in order to coordinate the fees and the daily distribution of costs.
Further developments of the work include an analysis of how the demand and supply of parking areas changed after the entry in operation of the new light railway in the City of Brescia.
Car parking management policies and strategies can help in promoting alternative and more sustainable modes of transport.

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Figg. 1, 2, 3, 4: maps edited by the authors (2012).

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ABSTRACT

This paper is a work in progress on Crowdsourcing. First, its concepts and importance are discussed and then its value for citizenship and urban planning. The motivation for participation and the display of geo-tagged information, as well as its possible applications in dynamic spatial temporal issues are presented, as well as its different approaches and applications. Furthermore, Crowdsourcing is discussed when the "ONVCêVIU", a VGI case study, is presented, revealing its origin, objective, free platform comparison - to select the proper tool to implement, the project's main challenges, results so far and further steps to be taken. To conclude a short review of the author's vision about what is to come in the future research.

KEYWORDS

Crowdsourcing, Volunteer Geographic Information, Citizenship, Urban Planning.

1 CROWDSOURCING ITSELF

This article presents a work in progress that seeks to understand the processes and applications of 'crowdsourcing' in urban planning. The term refers to the collection of geo-referenced data through tools such as VGI (Volunteer Geographic Information) and applications / interfaces known as APIs - Application Programming Interface. The information gathered from the crowd currently allows an infinite range of applications in various areas using geographic space as an element that composes analysis. This study is recent and utilizes state of the art cartographic technologies among others.

A crowdsourcing is a virtual geo-database collection with the possibility of voluntary cooperation. Other type of geo-databases may be acquired through API - Application Programming Interface - without the user having explicit knowledge that their information is being used. Interactive devices are used to view record and share spatially contextualized information. It marks spatial structures and promote communication about and between users. It enables communication information on usage and show new perspectives in geography, space and time. It utilizes the principle of dynamic mapping, which reveals mobility and concentration about groups of people around certain places or events during certain time periods.

It is important to differentiate the Crowdsourcing from VGI - the first is not voluntary. Despite of the information been posted voluntarily, it was collected through a data mining process and data are used without users having knowledge of it. The second depends on involvement and citizen participation. Crowdsourcing data mining today means a powerful form of search behaviors, trends and values.

The relevance of the subject is justified by the number of stakeholders in the decision processes of spatial and urban planning, among them: citizens, urban planners, chambers, retailers, manufacturers, transport companies, large corporations, banks and politicians[1].

To Miranda et. al. (2011) there is a special interest in VGI dedicated to urban mappings. We believe the most important and unique contributions that citizens can do related to their individual interests and first-hand knowledge, those are more related to applications and data from local GIS.

The possibility of interaction is through the diverse range of users. To various authors people are not seen only as consumers, but as contributors and creators of information (Silva e Davis Jr., 2008 and Goodchild 2007). This relation may completely change the way communities can take position towards many decision about their everyday space.

"Given a server with appropriate tools, the various pieces of the patchwork can be fitted together, removing any obvious inconsistencies, and distributed over the Web. The accuracy of each piece of the patchwork, and the frequency with which it is updated, can be determined by local need." (Goodchild, 2007). To the author, in essence, such developments contribute to a growing reversal of the traditional top-down approach to the creation and dissemination of geographic information.

1.2 VALUES OF CROWDSOURCING

VGI represents an unprecedented shift in the content, characteristics, and modes of geographic information creation, sharing, dissemination, and use (Sui, et. al. 2013). The social-political scene would improve and be improved by stakeholders participation through the use of VGI and understanding of time-space patters. It promotes empowerment, participation, grater political legitimacy, improved decision making, enhanced

[1] Class notes of the subject "Supporting Planning Processes by the Use of Dynamic Visualization" ministered by Prof. Dr. Stefano Pensa from Politecnico di Torino, Italia, at NPGAU – Núcleo de Pós Graduação em Arquitetura e Urbanismo at Universidade Federal de Minas Gerais in second semestre 2013.

services (and public service) delivery, it enables better management and planning of land use change, greater understanding of environmental issues and achievement of sustainable development, promotes innovation, knowledge gain, new business opportunities as well as applications and job creation (Roche, 2013:20). For the author, the value of VGI has been dramatically high in terms of social and political changes and also in terms of social cohesion. The author calls the attention for VGI as a potential learning and innovation tool and indicates it as a social learning process:

"…a spatially enabled citizen is characterized by their ability to express, formalize, equip (technologically and cognitively) and of course consciously – or unconsciously – activate and efficiently use their spatial skills. We argue that being involved in VGI activities is actually one of the more preeminent means for individuals to develop their spatial enablement. This improvement is another characteristic of the social value of VGI."(Roche, 2013: 21 in: Sui, et. al.)

On the web there is an interesting use of a crowdsourcing called "mass value assessment". Here, projects such as Trip Advisor website, Foursquare and others are indicated "to provide interesting insights into the ways that individuals and groups can use VGI to reshape and redefine how places are represented and understood" (Roche 2013:26 apud Graham and Zook 2011 in: Sui et.al.2013).

Users are not seen only as consumers, but as contributors and creators of information (Silva e Davis Jr., 2008 e Goodchild 2007). A great interest in more spatial enabled individuals is particular interest of this article, as it is one of the key instruments to our PHD study methodology to better seek a greater construction of a society more prepared for spatial decision making and it practicing its citizenship.

1.3 MOTIVATION FOR PARTICIPATION

Participation and its motivation lead to several questions that are very important and were made by Goodchild (2007). Why is it that citizens who have no obvious incentive are nevertheless willing to spend large amounts of time creating the content of VGI sites? What kinds of people are more likely to participate, and what drives them to be accurate (or inaccurate)? To the author, self-promotion is clearly a motivating for web activity.

As shown by Professor Dr. Michele Campagna in a course presented to our work group, participation on his VGI project "Place, I care" only happened during a certain period of time. We are also experiencing that kind of issue in our beta projects (a case study shown here and others constructed by students at a subject taught by the author and supervised by Professor Dr. Ana Clara Moura at Architecture and Urbanism course called "Collaborative Planning and Citizen Participation"). It leads to the comprehension that people have low motivation to practice citizenship and we conclude that alternative motivations should be part of a VGI project.

As explained before there are two types of crowdsourcing projects, one is VGI where the person volunteers to participate and other one through API where the person in his own social media experience offers geotagged information.

The perception is that a person should have strong motivation to take part of a VGI project such as a commitment, is really interested in the results or the VGI project clearly leads to policy of interest of the person. On the other hand, a crowdsourcing project conducted through API can use social media geo-tagged information where motivation is more related to self-promotion. In a different level many users contribute to 2.0 web as volunteers as a way to let information available to friends and relatives, without being worried if it will be available to all. (Goodchlild, 2007). This should explain the Picasa website popularity but it does not explain Flickr and Wikimapia where the content is completely anonymous.

1.4 APPLICATIONS

Dynamic mapping is a research line benefited by crowdsourcing and has been widespread in the last years by mapping elements that are well defined in terms of time and space. One of the basic principles of dynamic mapping is to reveal mobility and concentration of groups of people around certain places or events. For example, the origin of calls made by cell after a certain fact[2], the number of check-ins on social networks conducted in a location at a certain time or period (time of day, month of year, etc.). Location is a clear example of the information that can be used by the API's.

This was shown in the article "Discovering Landmark Preferences and Movement Patterns from Photo Postings". The paper shows how the trajectory was mapped during a certain period of time to determine preferred paths in Seattle concluding among other things:

"Spatiality of people's interests; locations of landmarks and events that are of interest to photographers; temporality of people's interests; dates of photographing places and events and the seasonality of people's interests; spatial extent of people's interests; boundaries of areas and events represented on photographs; connectivity between photographed places represented by a network of moves connecting places of interest; travel patterns of photographers and their temporal characteristics" (Jankowisk at. al. 2010: 850).

Other really interesting work related to time and space was published by Andrienko et all. (2013), "Thematic Patterns in Georeferenced Tweets through Space-Time Visual Analytics". The authors discovered through an API what topics were discussed in Seattle and their cluster distribution. They also found out their time distribution and topic relation concluding patters of time and space of twitter's posts are very mixed. In other words, when and where certain topics occupy peoples' minds are intensive related; as examples the work proved that "food" was twitted during lunch and dinner times, and people tweet about "transportation" most during workday rush hours.

The dynamic spatiotemporal mappings need assistance for reporting results and collecting information from the crowd. To support spatial analysis and its communication, geovisualization tools shall be very helpful. Great power to information are conferred to the domain of spaces and elements composed; it brings mastery over elements, relationships and topology causing the reader a better understanding of space and landscape, enhancing the information passed by attributing spatial arrangement of the elements that composes a landscape.

2 "ONCÊVIU" CASE STUDY

Our VGI beta project aims to test the model and contribution methodology established in www.fechoseucuido.crowdmap.com website, which the researchers call "ONCêVIU", it was created by NGOs Primo - Primates of the Mountain and CRESCE Institute - Reference Center for Education and Culture of Sustainability at Espinhaço's[3] and the support of GIS Laboratory of the School of Architecture of UFMG (Federal University of Minas Gerais) and DCC (Department of Computer Science at UFMG). The project is set in the context of the community campaign: "Fechos, eu cuido!" (www.fechos.org.br) and aims along with researchers unravel the community interaction with nature through Geographic Information Voluntary model.

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2 See http://senseable.mit.edu/realtimerome/ access in November 2013.

3 *Espinhaço* is a Biosphere Reserve and mountain chain at Central Minas Gerais protected by the Unesco's Man and Biosphere project.

Several platforms were analyzed to determine which one would be used to "ONCêVIU?" Project. The choice was made by the Ushahidi because it owns Smartphone applications both at apple store and google play, allows data download, and have many possibilities for the platform administration.

Another very interesting thing about Ushahidi/Crowdmap is that through the website is possible to create a project website without mixing the map information with other projects. They have a great support team and many pages of discussion forum. Another interesting thing about Ushahid is that according to their website (www.ushahidi.com accessed in March 2014) they have grown from an ad hoc group of volunteers to a focused organization in 2008. Their current team is composed by individuals with experience ranging from human rights work to software development. The website reveals that "Ushahidi", means "testimony" in Swahili, and was a website initially developed to map reports of violence in Kenya after the post-election fallout at the beginning of 2008. Since then, the name "Ushahidi" has come to represent the people behind the "Ushahidi Platform". Their roots are in the collaboration of Kenyan citizen journalists during a time of crisis.

PLATAFORM	DOWNLOAD	SMATPHONE	OTHER INFORMATION
www.urbotip.com	Yes to registered partners	Yes, android and IOS	The website is a mixture of all applications, does not allow photo posting and page customization.
http://geo.lbd.dcc.ufmg.br/strepitus/	yes	no	Developed by Computation Science Department (DCC) at UFMG (Federal University of Minas Gerais, Brazil). Does not have a very friendly interface and page customization.
http://maps.mootiro.org/	Does not inform	no	Does not allow customization of the website.
www.crowdmap.com (Ushahidi)	yes	yes	Allows customization of categories and website, photo posting, Facebook interaction and other functions.

Tab 1 Free VGI platform comparative

The collaboration began to be collected in August 2013, some adjustments to the project must still be performed as change of address access 'http://fechoseucuido.crowdmap.com' to a friendlier address for better understanding of the user and through links from other related websites.

As collaborations are being collected and the project spread among the local community studies of the tool and the theory that is based on this type of application are still being developed within the Geoprocessing Laboratory of the School of Architecture and conducted by the authors of this article.

Despite the project was intensively announced at several events, such as posters been placed in the community pubs and other places, contribution has not been many. The project has had, to date, only 199 visitors performing 240 hits and 47 reports. Of the 47 reports, 15 are in the landscape category, 15 in the fauna category, flora had 12 posts, 3 posts about complaints, 1 report on sewage and garbage category and no account under water3.

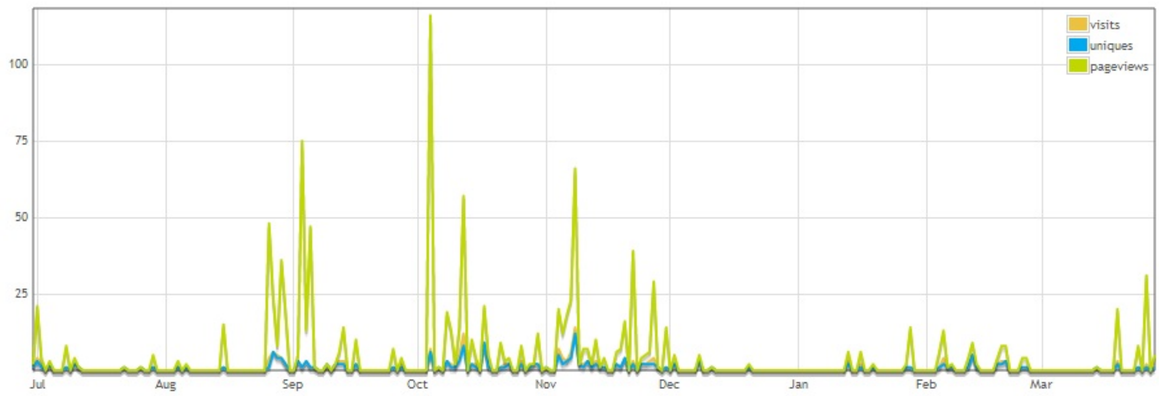

Fig. 1 Admin dashboard of "ONCêVIU" project. Access in March 2014.

The admin dashboard explains that visit is a record of a unique visitor coming to the site more than 30 minutes past his/her last page view. Unique is the number of individuals coming to your deployment; Unique Visitors are determined using cookies. In the case that a visitor does not have cookies enabled, they will be identified using a simple heuristic taking into account IP address, resolution, browser, plugins, OS, etc. And page view is the total number of pages that visitors have viewed on the site.

To broaden the dissemination of the project, next steps will be schedule at local schools posting activity to try to engage teens. Also as demonstrated, another need is to change the project address (http://fechoseucuido.crowdmap.com) for some simpler, and there is likely to be www.institutocresce.org/ onceviu.

Posting of reports and comments on the fan page of Instituto CRESCE (www.facebook.com/institutocresce) is other activity that has been performed and, according to statistics from the fan page, it did not reach the public. On the other hand, the project banner posted on November 10, 2013 had 335 views, 55 clicks and 24 "enjoy", comments and shares in the publication. This analysis shows that the reviews of posts in the crowdmap posted on Facebook are not giving results, but the creation and dissemination of graphic works can be more effective.

Another way of publicizing the project is through partnerships. In this sense contacts with Manuelzão Project, Rio das Velhas watershed committee and its subcommittees, communications media and NGOs are already being made hoping for a better dissemination of the project and enhancing participation.

3 ONCOMING CROWDSOURCING RESEARCH AND FINAL CONCLUSIONS

In a landscape conformation where there are many hills and mountains people who experience the space are usually immersed in river basins, or even at urban environments with physical barriers provided by urban facilities or buildings, landscape provides a barrier over look. An allusion to earthworms can be made, which live underground and have limited knowledge of what they will find a few inches away. If we understand well the concept and proposal of geovisualization, simulations and models of representation by mapping provide expansion of the horizon of the landscape area. The topological relations in construction of mental maps are represented and translated by simulated display bringing better understanding of what is presented around physical barriers beyond the horizon allowing a better understanding of space through the perception and cognition of the individual.

This realization brings out the conclusion that the field of geovisualization techniques facilitate communication and understanding of the issues addressed in the research related to events and arrangement of elements in geographic space. However, penetrations are required for the development of tools and techniques in order to qualify geographical better communication. An example of what it hopes to achieve can be seen for the site (http://leandigo.github.io/leanorama/ accessed on November 26, 2013). Similar studies have been conducted by GIS lab at School of Architecture and Urbanism through virtual navigations performed. The dissertation of Vanessa Godoy published in February 2011, with the title: "Cultural Landscape of Rio de Janeiro Centro - Identification, Characterization and Representation Looking community with the support of cartography and Virtual Navigation" is a clear example of these efforts. The first efforts of the laboratory began in 2003 with the doctoral dissertation the coordinator of laboratory Ana Mourão Moura, which resulted in the book GIS in Urban Planning and Management (Moura, 2003), there are also chapters of the book (Moura 2009 and 2010), articles on the case study of the Capão Xavier Mine (Moura and Amorim, 2007), and the Estrada Real project that indicate the studies from the laboratory that them as well as the dissertation work of the Author oriented by Professor Ana Clara Moura ""Fragility and Potential Use of Landscape Study and Touristic Caring Capacity of the Serra do Cipó National Park – MG"(Borges and Moura, 2011) that also used panoramic views to determine community and tourists better fit into simulated amounts of people at the park's main attraction.

The use of interactive devices for viewing, recording and sharing information spatially contextualized facilitates the participation of the reader, therefore, simulate a three-dimensional environment allows the eyes to feel 360° viewing space. Understand the difference between the zenith and azimuth vision is needed to better grasp the above concept - what is seen in the vertical and horizontal respectively. These modes of understanding and appropriation of space demonstrate how a regular citizen visualize and experience the landscape. The physical characteristics of azimuthal position of a person on the landscape, creates difficulties understanding the overhead perspective (horizontal). We know that despite the advent and understanding of tools like Google maps understanding and seizure of information by "ordinary" citizen gives the azimuth to the detriment of the zenith (Google street view at the expense of Google Maps). People understand better representations of space when watched horizontally, i.e.: simulating the human vision , when the target moves to the top (zenith) the way of understanding shall be changed , making it difficult to understand for some people.

Howard Gardner, an American psychologist and professor of cognition and education at Harvard School of Education, discusses the theory of multiple intelligences for a long time (Gardner, 1987), which is to determine different aspects of the human intellect which, according to him, are called intelligences. Gardner mentions a few types of intelligence, among them: body, spatial, logical-mathematical, linguistic, naturalistic, intrapersonal, interpersonal and musical. In describing the formation of the human intellect the author points out that people have levels / suitability of development of the different intelligences.

According to Gardner (1987) spatial intelligence is related to the ability to form a representation of the world. "In your mind you operate on that representation of the spatial world". The author points out the capacity for spatial orientation, popularly known as sense of direction, the three-dimensional visualization capability, i.e. the ability to view the design any object, imagine and manipulate this object, view it from other angles.

Understand the mind of the main users of a VGI project 'ordinary citizens' is a way of apprehend information as well as to provide a combination of different "geovisualizations" about the landscape shall be a way to solve the problem of empowerment landscape among communities and better interaction for solving problems that deal with the tangle of landscape elements.

Therefore, a VGI should have a better geovisualization to provide search and dynamic interactive information for visualization of cartographic layers (webgis) facilitating the understanding and mitigating the problem of information shown on static maps.

There are certainly gaps in knowledge about how to present spatial information to regular citizens. This understanding and appropriation of space lead us to the formation of mental maps:

> *"Man, after capture information from the environment through sensory stimuli, immediately recognizes and compares experiences and can thus generate a mental map of the environment in which it operates affectively. In addition to identifying and relation, the observer gives meaning to objects and these objects often refer to observer memories and sensations that vary from person to person."* (Godoy, 2011:63)

The virtual simulation of scenarios allows transporting the mind to another place. Navigation provides a dynamic change eye for landscape (cultural or environmental) enabling empowerment and interpretation. There are many examples of this technique: virtual navigation in museums, environmental learning (i.e. the video "From Spring to the Tap"[4]), virtual navigation in parks, tourism support, presentation of projects of intervention in the 3D landscape mappings, cinema, animation, archaeological sites, etc... Miranda and others (Miranda et.al., 2011) indicate SDI – Spatial Data Infrastructure as other area that can benefit by voluntary contributions: (i) new layers of popular interest, usually not produced by official maps; (ii) an indication of the need for corrections and updates, (iii) inclusion of additional details of local interest, (iv) name registration and geo- tagging locations (geographic index).

Because of its unimaginable applications about the landscape comprehension and number of stakeholders that can be involved in Crowdsourcing is proved to be a great tool for urban planning either applied as a VGI project or through an API research. On both methodologies of collecting crowd information the gain of knowledge is clearly present. Especially when the urban planner leaves the designer authorial position decoder for the collective will and establishes boundary conditions of use that are representative of what is valuable to society.

All these possibilities demonstrate that great knowledge gain can be brought to many activities and contemporary problems of space management specially those related to managing the space such as urban planning. It is clear that the local information is generally perceived and understood more clearly by those who experience it and if they have the knowledge and proper tools to demonstrate that knowledge it can be of enormous advance and show wisdom decision making.

View the dissemination of geographic information between surveys that deal with elements of the landscape and the extension of the techniques of man's interaction with the process of information production on a micro scale through VGI's, shows that thinking in new directions to geovisualization is an important instrument of "power" and dominion over the territory as a tool for community empowerment.

The understanding of geovisualization becomes crucial to build effective VGI projects or more applications for communication and building understanding of space by users. The fact that it allows us to understand where there are geo occurrences listed in the database, the voluntary collaboration has been indicated as a key to the understanding of several factors, however there is still the barrier of empowerment of information to be arranged.

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[4] http://youtu.be/z5z7KWloQIQ accessed at March 2014.

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SPATIAL PERCEPTION AND COGNITION REVIEW

CONSIDERING GEOTECHNOLOGIES AS URBAN PLANNING STRATEGY

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ABSTRACT

This article proposes a review of the spatial cognition and perception principles, referring to the definition proposed by Cullen and Lynch, through the geotechnology tools. It presents a case study to be analyzed through Geographical Information Systems (GIS), 3D Modeling, Spatial Analysis and Data Base Structure. This proposition presents reflections about the concepts and values of the early foundations of the spatial perception and cognition theories as a base to promote participative planning, investigating how geotechnologies can favor the registration and identification of landscape values to be considered in urban planning. The downtown of Belo Horizonte (Brazil) was defined as a case study to promote the exercise of these reflections, aiming to present a practical illustration of the methodological proposition. This work tried to reach its purpose inquiring how geotechnologies could enhance knowledge gain in the Urban Planning practice. It points out some research paths that could be followed, as well as new approaches to the development of academic understanding of the geotechnologies role in the urban planning scenario.

KEYWORDS

Perception, Cognition, Spatial Analysis, Geographic Information Systems.

1 COGNITIVE ASPECTS OF SPACE, AN OPPORTUNITY TO GIS

This work started with the idea that: representations of the world, beyond the sensory field, are, in addition to a physical view of the space, being formed with and through the mental faculties of the human being. As indicated by Faria [4] "the view is very far from being confined to the sense externalized through the eyes: it is constructed in the mind."

Thus, this research seeks to consider relations between subject and object and is based upon foundations of perception and cognition spatial theories, with priority to visit works that deal with this subject. From then, this inquiry tries to point out how the physical object and relational spaces could enable a transformation of sedimented perceptions towards the construction of strategies for Urban Planning.

As theoretical bases, classical authors were discussed, such as Kevin Lynch [12], with *The image of the city*, and Gordon Cullen [3], with *Urban Landscape*. On one hand Lynch's readings gave support to perceive "place" concepts through structuring elements, mental map creation, legibility conditions, landscape identity and singularity. On the other hand, Cullen's references helped in the identification of place's cognition, considering one's insertion in a landscape and the proximity of all points of view that it encompasses. Both approaches enabled the identification of *genius loci*, which can be defined, according to Norbert Schultz, as the character of a landscape, what is valued by the community, and must be considered by urban projects [19].

To carry out this exercise, the methodology proposed investigates the potential of geotechnologies and tested it on a case study at the city of Belo Horizonte (Brazil). The choice of the case study refers to the facility to visit the place and to identify axes and notable figures from the point of view of the user's location and culture. It is understood that this relationship promotes the understanding of the processes investigated by reinforcing the importance of space to the human being, and particularly of the changes that are proposed and designed for the environmental and urban space.

2 URBAN PERCEPTION AND COGNITION: THE PROCESS OF FORMING REPRESENTATIONS

Currently, the practice of spatial perception in daily life is superposed by the fast pace of big cities. The need for comfort and displacement ultimately dictate the relationships between subjects and things, and between the subjects themselves. For Lynch [12], "the moving parts of a city, especially the people and activities, are as important as their physical properties and parts."

In this sense, the development of technologies can facilitate the "automatic" understanding of objects and their surroundings. Consequently, seeing the world, beyond the act of "seeing" becomes a distant action of individual and collective naturalness, which is rationalized and becomes part of cold and distant feelings, emotions and affections reality that usually, connect to sensory experiences. Thus, "in most cases, our perception is not full, but very partial and fragmented while involved in other references [12]".

Besides the spatial perception, understood as the instinctive ability of human beings to create a mind map, with references to location and shift in the territory, resulting in the primary identification with the space in which it operates, is also relevant in this research the concept of spatial *cognition*.

The concept of spatial cognition relates to use conditions of memory and sensitivity, and enhances the sense of *space* to be hierarchical among the sense of place, equipped with related spatial experience values. Cognition occurs when there is apprehension of how the world works, with its forms and principles. Cognition is not a static or passive concept, since it is not determined, but conditioned and contextualized.

Through cognition, the subject can transform surroundings according to the cultural baggage that moves him.

Among the authors of spatial perception stands out Lynch [12, 13, 14], and also, in Brazil the group of Brasilia University conducts studies on the topic [11]. In this framework other authors should be cited such as Tuan [27, 28], which discusses the relationship of topophilia (feeling for the place) and space and place; Schulz [24], who introduced the concept of *genius loci* (essence of the place) and Cullen [3].

The moment of perception and cognition of space is a time of social consciousness. It is the funding, selection and organization of environmental information process-oriented decision making. Largely automatic and even unconsciously, a person uses internalized spatial, architectural, urban and landscape understandings to compose a mental frame of the organization of their surroundings and coherence in the dynamics of its functioning.

The revisiting process of perception and cognition theories involves passing from the importance of space to the importance of man-space. This review may contribute to increase understanding about the contemporary city once such process is directly connected to the quest of understanding the subject who experiences space socially produced through experience, memory, intellect, imagination and emotions. This subject “re means” the concerned space and gives sense to the plastic shapes and their relationships.

The figure of the Architect and Urbanist arises in this interim as a decoder process agent including shapes and data. Thus, the “decoder-architect” can enrich the environmental perception, by entering the other beings world to decode it. Therefore, the Architect may come to infer about perceptual reality of the collective social and also about the creation of other sensations from new urban design.

For Cullen [3], the role of the architect, *designing* (related to the *decoder* role here), was disturbed by the speed with which they operate changes. To the author, “the rate at which the changes are processed today prevents urban planners to apprehend and settle empirically to humanize the raw material that comes across them. The environment is poorly digested”. [3]. It is interesting to note that the reasons that caused this statement made by Cullen, more than forty years ago, still remain related to such imbalance: “there is more people, more houses and more equipment; increasingly rapid communications, construction methods still poorly mastered”, can still be appointed by architects and city planners as a problem for the appropriate perception that leads to well-executed project [3].

In response and indication on how to do planning in such conditions, Cullen emphasizes the need to “popularize as most as possible the *Art of the Environment*.” For the author, “the way the environment is constructed is potentially one of the most widespread and exciting sources of pleasure” [3].

Cullen's approach reinforces the need to analyze and study the process of uptake, assimilation and understanding of space by individuals who experience and make their place. In this sense, the architect must take its partial role, intention, and seek a way to translate and decode the desire of the collectivity. The partial role pointed here refers to the cognitive process in the human sciences which will never be fully apprehended and understood, they will always be more accepted solutions and they will always be partial.

3 CONTEXT

“Currently, has grown by town halls the interest and investments in Urban Planning, one time that the organization and life quality in municipalities depends directly of this. Consequently, the demands for tools that enable the creation and analysis of constraints data of this planning have been each time more frequent.” [5].

Belo Horizonte is the third largest metropolis of Brazil and, despite its present great advances in public policy and environmental planning, and possess a Master Plan [20] well structured, needs, as how the rest of the country, of strategies and tools for their development considering the landscape as resource planning. In this sense, is scarce the material about municipal normative that addresses the process of land parceling, use and occupation from a landscape perspective. Also, when addressed, is under a very broad conceptual look towards *general aspects that characterize certain areas*, as in the case of a Belo Horizonte Master Plan, which binds to the term *urban landscape*.

Regarding the development of the database, use of geotechnologies and adopting of spatial perception and cognition resources, the municipality, is a national reference of preparation and organization cartographic georeferenced bases. At the same time, "the town halls in general have a poor cartographic base of your municipality. Most of them appear just as papers collections with drawings of lots, often without special precision, reference points, projections nor appropriate scale systems. The drawings are represented in the form of sketches, without geometric rigor and non-georeferenced, hindering the creation of a digital database or providing large distortions in the same." [5].

The use of landscape as a tool for planning might allow problematizing, conceptualizing and especially developing the diversity of issues that involve complex urban environment. The cultural issues may be reviewed, and placed in a similar relevance level to natural issues. In this sense, the Urban Planning processes, which have been applied in Belo Horizonte and other cities, may expand its scope of influence or activity. At the same time, may cover the changing character of environmental realities, approaching its complexity.

Moreover, the adoption of features that search for the landscape resignification and revalorization, considering individual and collective perspectives, move in the same direction that recent research of this field, as pointed by Moura [18]: "recent scenario was one of recognizing Geographic Information Systems' potentials, as well as considering communication and information exchange processes, and initial legislation regarding propagation of information. In a process continuously more integrated and global, geo- technology tools started to respond to the following values: wide communication with different users; wide inter-operability; and wide promotion of systemic approach, by modeling processes and building interpretative portraits and simulators for reality." In this sense, Belo Horizonte can contribute, one more time, to the development of tools and instruments for a better understanding of urban, Brazilian and of other realities.

In Brazil, the current scenario of discussions about landscape shows a singular situation. According to Freire et al. [6], "given the intense process of urbanization wide-spread in the territory with forces acting similarly in a greater or lesser ex- tent, not only in large urban centers but as in medium and small size cities. The use of models and geotechnologies grows in importance in its way as supporting tools for planning, insofar as this interferes on planning and de- fining the landscape that must be understood as a right from all the populations of the cities. In Brazil, changes in legislation process increased popular participation. Thus, the development of studies and investigation of the processes of intraurban change, we must emphasize the utility of geotechnologies and their analysis techniques"

4 INFORMATION MODELING FOR URBAN PLANNING

Under Freire et al. [6] the main features of the projected visible urban landscape can be synthetically quoted as follows:

- The urban landscape is endowed with projected visible dynamism, and is a product of human action that produces a superimposed palimpsest [2, 10, 22, 25];

- It is endowed with a historical dimension combined with a spatial dimension [23];
- The architecture and urbanism aspects are inseparable in the urban landscape, since it is the result of the interplay of these aspects [7];
- Its interpretation depends on the observer's point of view, since it is the result of cognitive processes [15), and also who presents to the public, as this presentation may be imbued with some kind of strategy, for example, related to entrepreneurship [10, 26].

If we can embrace the variety of information that provides the environment when we represent it, we can achieve the diversity of possible perspectives, starting from the object towards the look. The 3D representations carry the potential to cover the environmental spatial and temporal changes, favoring an acceleration of understanding of the spatial processes and phenomena. At the same time, allows the combination of different perspectives, even simultaneously, by handling your tools and building models of representation.

Santana [21], referring to Campagna says: “The conditions that now presents allow the urban planner to simulate, in expanded reality, the resulting on landscapes of their propositions of zoning, occupation models and tables of urban parameters. This employed more largely as tool by the urban planner will allow the bridge among technical, administrative and community languages. Everybody will be able to give opinions and to make decisions, democratically, favored by the best ways of com Giacomelli [8] states that the complexity of those models and the variety and volume of information need to be studied in terms of environment of processing and post-processing, related not only to GIS technology.”

5 METHODOLOGY

The first step to execute this work was to identify the most important authors that dealt with space understanding of. We identified Cullen and Lynch as the most relevant to the analysis and others to support some issues. Both have pertinent work towards spatial cognition and perception despite the long distance that they were conceived.

It is well understood and proved that geotechnologies enhance and improve understanding of spatial relationships, so it instigated the research group to revisit Cullen and Lynch concepts using these tools.

As theoretical framework the review and considerations about the concept of urban landscape stated by Gordon Cullen establishes from the process of forming representations that the city is a locus of urban social changes, shall serve as a palimpsest and laboratory for possible interventions in the intention of producing a less segregated and more just space. This concept summarizes and clarifies the difference between a *landscape* and *tangled objects*, and serves as an instrument for establishing relations between objects seen/perceived and the subject. For Adam [1], Cullen`s definition to the urban landscape “is the art of making coherent and organized, visually, the tangle of buildings, streets and spaces that make up the urban environment.”

To Gordon Cullen [3], the urban landscape is made up of space in which “society shares experiences of pleasure and conflict, encounter and clash, inclusion and exclusion, in a historical dimension that reflects the experiences of its inhabitants”. The author highlights the dynamic and propitiator character of various interactions of the urban landscape, defining it as a locus in constant transformation. [3].

To understand this concept and the examples designed by Cullen, some sites where examples could be perceived were mapped in the city of Belo Horizonte. To address the research, a layer of information with the data was created through a table containing: concept, photography of site, and other comments. Then the occurrences were indexed to corresponding locations of each photograph (Figure 1) using georeferenced points.

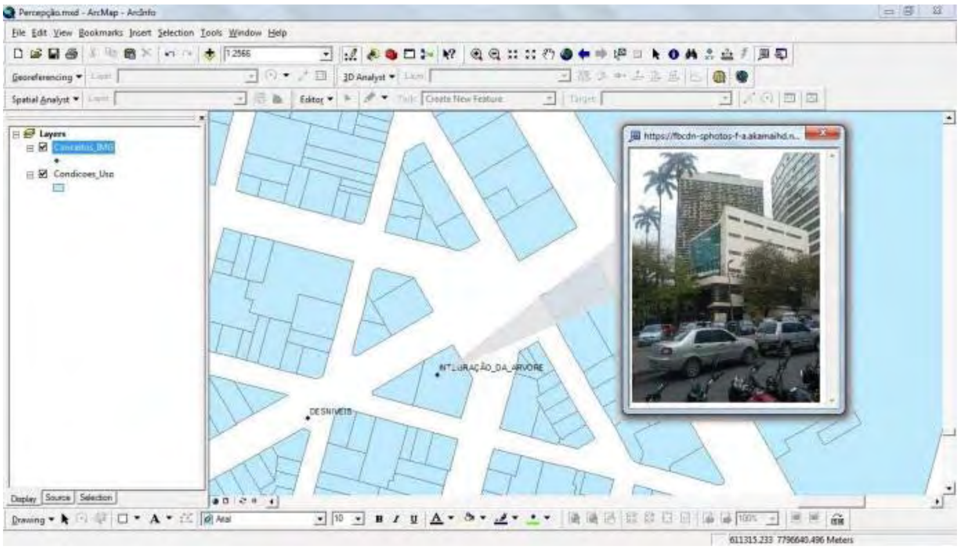

Fig. 1 Mapping of Cullen´s Concepts

After this step, the issue of the space perception through "serial vision" [3] was deepened. According to the author "the path from one end to another in a plan, for example, shows a sequence of views. The uniform progression of a walker is punctuated by series of sudden contrasts that have great visual impact and give life to the path". [3].

Such indexing, was part of a search for exemplifying Cullen "themes" through new technologies for spatial analysis and relate them to the current reality and to a different spatial area than those shown in Urban Landscape [3].

The potential of geotechnologies favor the revisits to the principles of spatial cognition and perception, to create conditions for practical use in processes of interpretation on environmental and urban planning. Among the resources made available by geotechnologies, more specifically by the Geographic Information Systems (GIS), those which were included in this research can be highlighted:

- Georeferencing information and the possibility of overlapping and combining information from layers;
- Association of cartographic and alphanumeric database and the possibility of feeding it with information detailing the occurrence data;
- Organization of a database;
- Three-dimensional modeling;
- Implementation of combination of variables models;
- Implementation of point of view models.

6 DEVELOPMENT – CASE STUDY APPLICATION IN THE CENTRAL REGION OF BELO HORIZONTE

Some countries, such as Britain already adopt sight fields as a parameter for approval of building impacts. *The London View Management Framework*, for instance, provides protection for some targeted views from defined points of the city considered important as they help define the city's identity (Figure 2). The applications of this type of analysis are related to the possibility of identifying notable landscapes and, above all, identify the values to be preserved concerning transformations of the urban landscape.

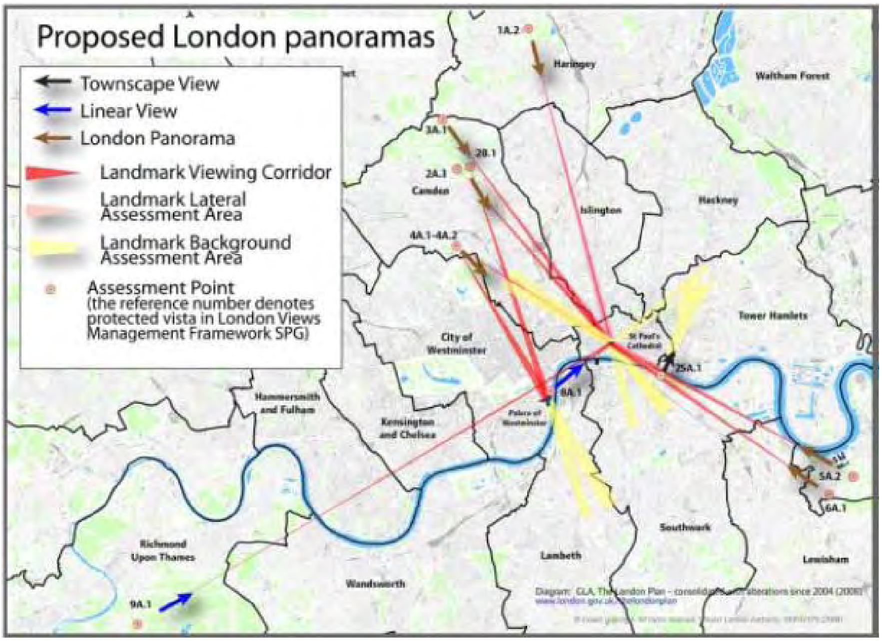

Fig. 2 Map of protected views

Nowadays the municipal law of Belo Horizonte addresses the issue of sight fields only when they are related to the Serra do Curral. Although this mountain range is of great importance and scenic beauty, it is noted that Belo Horizonte, like other cities, when one considers the principles of perception and spatial cognition, has few cultural and historical values sight fields of interest officially contemplated and protected by regulations. So as experimental case study, aiming to expand the panorama of protected sight fields a stretch was chosen in downtown region to demonstrate its importance to their viewing angles. The chosen stretch includes Amazonas Avenue, starts at the Raul Soares Square and goes until Sete de Setembro Square. It also is part of the original urban plan of the Belo Horizonte, designed by the engineer Aarão Reis in the end of the 19th century (Figure 3).

Fig. 3 Case of study area and the viewpoints analyzed

After choosing the stretch, a situation of a person walking on the sidewalk, on the right side of the Avenue Amazonas towards Sete de Setembro Square, was proposed. From then, the research group tried to analyze the landscape by applying the concept of *serial vision* [3] and studying the sight field at each point (Figure 4).

Fig. 4 Application of Serial Vision in the first part of the study area

To study the sight fields, *GeoWeb 3D software* was a valuable tool, because it raised a layer from the ground containing the projection of buildings on lots and their respective heights; allowing the analysis of visible and invisible points, since the point of the observer (Figure 5).

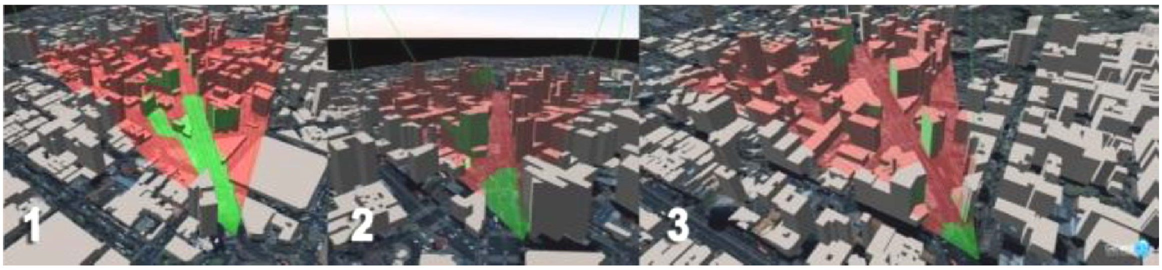

Fig. 5 Field of view analysis related to the first photo sequence (Software: GeoWeb 3D)

Note that the same landscape may prove functionally distinct if placed second different viewpoints, as shown in the second sequence of photos and fields of view (Figures 6 and 7).

Fig. 6 Application of Serial Vision in the second part of the study area

The sequence of figures shown (Figures 4, 5, 6 and 7) confirms one of the functions of the height differences described by Cullen, in this case clearly separates the studied stretch into two parts (Figure 4, 5, 6 and 7 - sequence of photos 1-3 and 4-7).

In the second sequence of pictures (Figure 6 photos 4-7) we see how it defines a focal point [3] on the landscape. It is a symbol of vertical convergence. In our case, the obelisk of Sete de Setembro Square emerges as a confirmation. Although the heavy traffic has lost the clear function of room, the “lollipop” (as it is called by citizens) marks the main road crossing of Belo Horizonte.

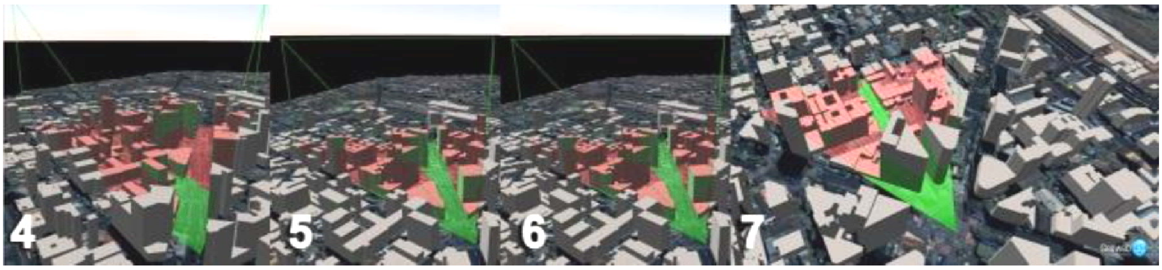

Fig. 7 Field of View Analysis related to the first photo sequence (Software: GeoWeb 3D)

Throughout the selected stretch (Figure 3), the distinction of typologies, shapes and sizes of buildings and landscape elements inserted excitement and drama to the route away from the monotony of a continuous landscape, bringing in all the attractiveness of the unexpected, where the landscape is not only appreciated by individuals, but is in constant interaction with the environment, merging it.

7 CONCLUDING REMARKS

It is recognized through this work that the urban landscape is not considered only by a combination of fixed elements such as buildings and threes but also from the movement of the people among the objects and its interdependent relations. In this sense, the social behaviour shows extreme importance to the study.

Cullen’s work show that as the disposition of space can interfere in the emotional aspects of individuals, its applications in Urban Planning should be adopted in a way to accomplish more attractive and comfortable spaces to user even though considering different ideas, tastes and wills.

The value of the use of geotechnologies is highlighted more specifically in the GIS use and the review of the spatial cognition field of research. Among GIS tools that were implemented stands out the construction of a data base, three-dimensional modeling; implementation of combination of variables models and implementation of point of view models. This tools matching contributed to associate the concepts and the methodology of urban landscape interpretation with a more integrated analysis as stated in the beginning of this research. It was possible to produce a combination of different information with significant power of visualization. This path can be of great value to future development seeking the participative planning support as it is a way to act as principle of “see the unseen” [17].

This research started a path that can promote a way to understand and consider the values of a community to the landscape impacts in the urban planning scenario. In the case study area there are no rules, legislation or parameters that take community opinion or cognition relation in to the decision making process. The paper sought an efficient path that governments, stakeholders and urban planners might start taking into consideration once used accessible instruments.

At the time the spatial perception and cognition theories were initially proposed, the set of tools for representation, visualization and spatial analysis were limited, which has given rise to many improvisations that ended up disqualifying the value of such studies of the relationship between user and territory. Yet, when facing new and meaningful opportunities arising from geotechnologies and the diffusion of information, it is possible to review concepts and extend investigations, considering that there are already tools which used in appropriate methodological processes, might favor analyses with repeatable and defensible criteria.

The instruments shown here are also tools that can help academic development, once they represent a way to promote exercises, be a new subject into the graduation courses curricula, where the understanding the landscape progress is fundamental.

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Fig. 1, 4, 5, 6, 7: Author's files.

Fig. 2: Mayor of London. The London Plan: Spatial Development Strategy for Greater London. http://www.london.gov.uk/thelondonplan/docs/londonplan08.pdf. Feb. 2008.

Fig. 3: Google Maps (accessed in January 2014).

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DILEMMAS IN THE ANALYSIS OF TECHNOLOGICAL CHANGE

A COGNITIVE APPROACH TO UNDERSTAND INNOVATION AND CHANGE IN THE WATER SECTOR

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ABSTRACT

In this paper we argue for the need to apply a cognitive approach to understand deep dynamics and determinants of technological evolutions. After examining main contributions from innovation studies to the conceptualization of innovation and change in complex socio-technical environments, we highlight the contribution coming from the application of the cognitive approach to evolutionary studies on technologies and we introduce the concept of technological memory as an interpretative tool to understand those changes. We discuss our hypothesis with reference to several observations carried out in different local contexts – Mexico, India and Italy – in relation to technological change in the water sector. In those cases deliberate attempts to substitute traditional technologies with modern ones led to interesting trajectories of change ranging from the collapse of old technologies to the development of multifaceted hybridization patterns.

KEYWORDS

Technological evolution, Innovation studies, Cognitive approach, Technological memory, Water

1 INTRODUCTION

Debates on sustainable technologies for urban and territorial management – being them related to water, transport, energy or any other major sectors – tend to be restricted to issues about how to support the transition to green infrastructures and more sustainable technologies. This means, on one side, a focus on key technological components and an evaluation of their technical performance, in order to support R&D efforts in sustainable directions and to "push" technological innovations towards greener outcomes; on the other side, this means a great attention to the identification of best possible governance, market and policy strategies to sustain a societal transition to them, i.e. their wider adoption within society. In all this technology tends to be treated like black-box, like something exogenously defined by engineering R&D efforts, on which society has, at most, the power to accept or reject it on the basis of its preferences.

Even if research on technological innovation has deeply tried to challenge that simplistic view by proposing social constructivist approaches to science and technology (Bijker et al, 1987; Bijker, 1995) and by giving a much stronger role to people besides their being passive consumers (Breschi and Malerba, 1997), technology is still commonly conceived of as linearly progressing along a technology-push approach to technological innovations. In this perspective, an heroic idea of technology, as resulting from the diffusion within society of radical inventions made by few, is still dominant (Shumpeter, 1934, 1942), as well as the idea of linear path of progress as proceeding from an old, backward technological past to modernity (Rostow, 1960).

But evidence from real case situations often shows the opposite, i.e. that technological evolutions are sometimes – if not very often – linked to the work of many distributed agents and thus follow a pattern nurtured by several micro-learning processes instead then pushed by large breakthrough events (Garud and Karnøe, 2003; Hendry and Harborne, 2011; Grassini, 2011). On the other side, they show that evolutions are rarely done along linear patterns of change, as they are marked by many returns and recombinations of traditional and new components and practices (for an account in the water sector see also Barbanente et al., 2012; Grassini, 2013).

While these observations have constituted the ground for empirical and theoretical research in innovation studies, research findings have rarely been linked in a more comprehensive theoretical framework of technology evolution. Moreover, a cognitive perspective in the analysis of technological change and innovation is still largely to be developed. In this paper we will try to address these issues by developing a cognitive frame to the analysis of technological innovations, with the final aim to help in shedding light on the functioning of the "black-box" of technology and its evolution.

In our discussion we consider technology as an organization of cognition-action abilities of individuals and societies aiming at reproducing their life and incorporating resources available to them. In particular, we will discuss the concept of technological memory as a medium to understand technological change (TC) in a cognitive and micro-organizational perspective and will try to address some major questions, i.e.: is TM a particular form of memory or does it comply with the dominant model of generic memory currently postulated?; what is the relation between social and individual learning in TM?; which influence does TM exert on evolutionary pattern of technological change?

This discussion will be done in relation to a case study about the evolution of water technologies in several local contexts, i.e. Mexico, India and Italy. Water technologies offer an exceptional stance in the above mentioned perspective, because of their centrality in the ecology of living beings. In this field, the centralized large-scale hydraulics produced by standard technical expertise is increasingly challenged by small and distributed hydraulics, bioregional, ecologically more resilient, produced by local common knowledge well adapted to the local environment (Borri et al., 2010).

In all three cases under examination in this paper, evolutionary technological patterns look particularly interesting since local socio-cultural and technological traditions at some points merged with external knowledge systems brought either by conquerors (this happened in the cases observed in Mexico and in India) or by more recently developed global/engineering science (this is the case observed in Italy). In all cases, complex trajectories of sociotechnical change developed, with traditional knowledge combining with other knowledge systems through multifaceted processes of domination and resistance. While these changes often led to the collapse of traditional systems, sometimes indigenous technologies resisted to the domination and evolved through interesting innovation and hybridization patterns, where tradition became not only a memory of the past but a generative force able to shape the future through innovation. In this process, cognitions and actions are strictly interwoven and activate new opportunities for change as a generative enactment process (Weick, 1995), where old concepts and routines are mixed with new ones.

The paper is thus structured as follows: in the next section we discuss major research findings in technological innovation studies with reference to systemic and co-evolutionary approaches to technological innovations and to the role of distributed actors in innovation processes. In the third section we then highlight potential and limitation of the actual application of a cognitive lens to understand technological change, thus introducing the discussion made in the following section about the concept of Technological Memory. Finally, in the concluding section we discuss key findings from the case studies, which are interpreted according to the TM lens.

2 EVOLUTIONARY PATTERNS OF TECHNOLOGIES

Innovation and technological change have been a core concern in economics as they have been traditionally considered at the root of economic growth (Schumpeter, 1942; Solow, 1957). In his book "The Theory of Economic Development" Schumpeter argued that development (at that time considered to be equivalent to the concept of growth) was the result of the innovative ability of the entrepreneur and his introduction of new methods of production (Schumpeter, 1934). In his writing technological change was considered to be proceeding through three stages, namely invention as the stage of generation of new ideas, innovation as the locus for the development of new ideas into marketable products and processes, and diffusion as the stage for new products and processes to spread across the potential market.

How to foster technical change and which are the determinants and effects of innovation and technological change have been highly relevant and intricate questions for economists since then, in the attempt to increase the rate of productivity of economic enterprises (Schmookler, 1966; Mansfield, 1968; Rosenberg, 1982; Griliches, 1984; Nelson and Winter, 1982; Scherer, 1986). The famous "technology push" model, which has been the basis for the development of the linear R&D model of innovation, is directly connected to Schumpeterian ideas and has been highly influential in the definition of policies to induce innovation. In this model, innovation is mainly proceeding from the engineering application of scientific discovery through manufacturing to the marketplace – thus having in R&D efforts the real boosts of innovation and reducing users to passive consumers of technological products. The demand pull model is but another version of this linear model of innovation, whose only difference from the other is the attribution of a more active engagement of users through market demand, which constitutes a source of new ideas to direct R&D efforts (Schmookler, 1966).

Both models paid little attention to the socio-cultural environment where innovation were supposed to take place, which was mainly narrowed down to a simple "selection environment" (Breschi and Malerba, 1997). They brought with them a powerful conviction that innovation and technological changes were a sort of "black box" (Rosenberg, 1982) proceeding as breakthrough events made by few talented innovators and that the growth of an economy was directly linked to the capacity to apply innovations and technological changes to increase its productivity. In this line, traditional entrepreneurship literature primarily attributed the success and failures of innovation activities to specific individuals (Gartner, 1988), mainly conceptualized as heroic individuals who have the ability to discover, create and exploit opportunities that lie beyond the reach of most.

At the same time, powerful economic theories postulated the existence of a linear progression of economic growth along a predetermined path from a backward past to modernity, with “take off” being deeply related to the capacity of countries to unload the traditions of the past and adopt modern technologies and models of production (Rostow, 1960). This strongly supported the transfer of technology as a key approach to spur economic growth within lagging behind economies. This quick-and-fix approach to the use of new technologies to solve complex development problems of developing economies dismisses glibly the achievements of the past (Agarwal and Narain, 1997) and underestimates and minimizes the many difficulties some of the new technologies have brought in their wake. This is particularly evident in relation to technological innovations for environmental management, where increasing critiques emerged highlighting the environmental as well as the social and cultural side effects of the application of the technology-push and the transfer of technology approaches (for the water sector see also Escobar, 1996; McCully, 1996; Postel, 2000; Shiva, 2001; Grassini, forthcoming).

At the same time, this conception neglected the differences of local contexts in terms of factor endowments and assets, including natural resources, knowledge and social and cultural capital. In so doing, the productivity of technological innovation along imitation curves run the risk to be significantly lower than that obtained from innovation efforts rooted in local factor endowments (Hicks, 1932). This is particularly evident in the field of natural resources management, where traditional technologies – which developed in close tune with the capacity of local population to exploit the potential of their endowments – undergo the tendency to be substituted by modern technologies ubiquitously transferred across the globe (Ahmad, 1966; Binswanger and Ruttan, 1978). On particular case of this tendency and a critique to its effect in wider terms have been recently discussed also in the field of water resources management (Kubursi et al, 2011).

Initial attempts to open the black box of technology and to show the more intricate and complex dynamics leading to innovation and technological changes were made within evolutionary economics, with its claim for a non deterministic description of technology development, the role of limited rationality of involved actors and the co-evolutionary linkages between technologies and organizational settings (Nelson and Winter, 1977, 1982; van den Bergh and Gowdy, 2000). The notion of “technological regime” (Nelson and Winter 1977, 1982) and of “technological paradigm” (Dosi, 1982), as an extension of the Kuhnian concept of “scientific paradigm” (Kuhn, 1962) to the technological field, were developed to explain the influence of cognitive routines shared by the technical community on technological trajectories of change.

The need to adopt a more systemic approach to technological innovations through a co-evolutionary framework of analysis encompassing technological artifacts as well as social, institutional and policy environment has been then reinforced by contributions within the field of history and sociology of technology (Bijker et al., 1987; Hughes, 1987), with the expansion of the concept of technological regime to accommodate the influence of a broader non technical community of social groups to the patterning of technological development (see the concept of “socio-technical regimes”, Bijker et al., 1987; Hughes, 1987). This emphasized the idea that scientific knowledge, engineering practices, and process technologies were socially embedded—i.e., seamlessly intertwined with the expectations and skills of technology users, with institutional structures, and with broader infrastructures (Kemp et al., 1998).

As a consequence of the acknowledgement of the multi-dimensional dynamics, which affect at the same time technology, user practices, policies and institutional structures through complex multi-actor processes, more complex frameworks for the analysis of technological innovations were developed within newly emerging research streams. One of this is the multi-level perspective on socio-technical systems (Rip and Kemp, 1998, Geels 2002), with its focus on larger "socio-technical systems" (Geels, 2004; Geels and Schot, 2010) – encompassing at the same time material artifacts, techniques, but also knowledge related to them (Raven and Geels, 2010), networks of actors, and institutions (socio-cultural norms, technical standards, regulations) (Voβ et al., 2009; Farla et al., 2012) – and its attempt to develop a theoretical framework to explain the non-linearity of technological transitions by the interplay of dynamics at three levels: niches, regimes and landscapes (Geels, 2002). Another is the field of technological innovation systems (Hekkert et al., 2007; Bergek et al 2008), which applies methodologies coming from the analysis of National Systems of Innovation or Sectoral Innovation Systems (Carlsson and Stankiewicz, 1991; Archibugi and Lundvall, 2001), with its attempt to overcome the narrow concept of market failure as the only responsible for poor diffusion of innovations and to single out a broader set of system failures, which encompass institutional, infrastructure, organizational aspects (Negro and Hekkert, 2008).

These frameworks have been successfully employed in the environmental domain, where they contributed to contrast the simplistic and overenthusiastic faith in the "technology fix" approach for solving environmental problem, which could only provide partial and temporary solutions due to rebound effects or other unintended consequences (Farla et al., 2012). In so doing, they have supported the birth of a newly formed field of research dealing with environmental innovation and "sustainability transitions" (Elzen et al, 2004; Geels et al., 2008; Smith et al., 2010), which specifically developed both detailed accounts of the formation of new socio-technical configurations, as well as frameworks for analyzing determinants of radically new modes of production and consumption. In so doing they try to find the way to sustain sustainable practices and technologies in their struggle against existing systems or "regimes" (Kemp, 1994; Geels, 2002) stabilized by various lock-in mechanisms that tend to lead to path dependence and entrapment (Unruh, 2000; Walker, 2000).

As a result of the application of the above mentioned analytical frameworks to the issue of innovation and technological change, several steps have been made in the direction to obscure long lasting convictions about innovations and technological changes. One of them is certainly the idea that technological innovation only proceeds through heroic and breakthrough events, which is increasingly challenged by a growing body of research dealing with those cases where innovations are not based on any new dramatic and breakthrough inventions or scientific discoveries, but rather on the steady accretion of inputs from many actors (Garud and Karnøe, 2003; Kamp et al. 2004; Hendry and Harborne, 2011; Grassini, 2011). This in turn is leading to the re-evaluation of the importance of a multiplicity of learning modalities – learning by doing, learning by using, learning by interacting – besides the much celebrated learning by search (Kamp et al., 2004), and to the acknowledgement of inherent fragility of high-tech breakthrough development patterns deriving from the technology-push approach as far as they tend to overcome and to stifle multiple micro-learning processes from distributed agencies (Garud and Karnøe, 2003).

3 A COGNITIVE APPROACH TO TECHNOLOGICAL CHANGE AND INNOVATION

Although more recent contributions of innovation studies and contemporary framework to understand the evolution of complex socio-technical systems pay large attention to inputs and micro-learning processes made by distributed actors as well as to the contribution of several types of knowledge to the process, cognitive factors, including attention, memory, and reasoning, did not receive any systematic treatment in relation to technological change. By application of a cognitive lens to technological change and innovations we mean the attempt to link technological changes with the way individuals and groups organize their knowledge about technology and make decision and act in relation to it.

Cognitive approaches have received increasing attention within the broader field of organizational theory (DiMaggio, 1997, Walsh, 1995) since the seminal work of March and Simon (1958), which highlighted the cognitive foundations – assumptions about the future, knowledge about alternatives and perception of possible consequences of actions – brought by individuals to management decisions within organizations. These set of givens – or "frame" (Goffman, 1974) – soon started to be recognized as a key concept to explain the way individuals make sense of highly complex and uncertain environments and are able to make decisions and actions in relation to it (see also Argyris and Schön, 1978; Schön, 1983).

The importance of cognitive frames and routines (e.g. search heuristics, exemplars, interpretations,…), which are shared within a technical community, in guiding and orienting engineering activities in the technological change process started being recognized within evolutionary economics with the introduction of the concepts of "technological regime" (Nelson and Winter, 1982) and of "technological paradigm" (Dosi, 1982) as important determinants of trajectories of technological change. Similarly, social constructivists used the term "technological frame" to encompass the whole set of problem agendas, problem-solving strategies, search heuristics, theories, design methods, testing procedures (Bijker, 1995) owned by a certain community and acting as retention mechanism through which communities store accumulated knowledge (Raven and Geels, 2010).

The very concept of "technological frame" is quite recent and comes from the attempt to draw on the concept of cognitive frames (Tversky and Kahneman, 1981; Weick, 1995) and to apply it to the context of technology in order "to identify that subset of members' organizational frames that concern the assumptions, expectations, and knowledge they use to understand technology in organizations. This includes not only the nature and role of the technology itself, but the specific conditions, applications and consequences of that technology in particular contexts" (Orlikowski and Gash, 1994, p. 178). In their work Orlikowski and Gash (1994) used the concept of technological frame to understand the dynamics of technological development and change within organizations and to explain the differences in the nature and extent of the early use of an Information Technology within an organization in comparison to expectations of technologists. In so doing, this work shows an increase in the difficulties and conflicts around the development, use and change of technology when technological frames of key groups within the organization (managers, technologies and users) are different. It furthermore succeeds in combining research on frames, which are individually held, with research on institutional analyses, which are concerned with the shared, taken-for-granted systems of social rules and conventions that structure social thought and action (DiMaggio and Powell, 1991). In this work, nevertheless, technology is still mainly considered as exogenously brought in organizations, so the focus in not much on the roots of the innovation system but on the adoption of some technologies.

On the basis of this work, some scholars tried to use technological frame as an interpretative system to understand corporate strategies in relation to technology, and ultimately their linkages with a competitive dimension of the firm (Acha, 2004). Also in this case, the focus is on inter-organizational dynamics in relation to exogenously driven technologies, but the work is insofar interesting as it underlines the competitive advantage of the match between technological features and technological frames of key people within specific organizations.

One interesting attempts to use a cognitive perspective to explain patterns of technological innovation has been made by Paul Nightingale (1998), as far as he uses a cognitive approach to demonstrate that the application of science to produce technology can only happen through the mediation of tacit knowledge (Polanyi, 1967), i.e. the background of interwoven experience and the capacity to relate experience to it, and tacitly understood traditions of technological knowledge that co-evolve with technological paradigms. In so doing, he maintains that technological innovations are directly linked to embodied and socially embedded technological traditions, i.e. a set of beliefs, based on previous design experience, about how technology should function and how problems in the innovation process should be solved.

Although his reasoning is applied to a very simple case of technology innovation, which does not encompass all complex dynamics rooted in micro-learning processed from distributed agencies which often nurture the cases of socio-technical innovations in the environmental domain, this research shows the importance of tacit understood traditions of technological knowledge, which are embodied in the brain and embedded in socialized practices.

Following the work of Nightingale, Kaplan and Tripsas (2008) applied a cognitive perspective to explain technical change by developing a co-evolutionary model of technological frames and technology. In particular, they identify technological frames as a source of variation in the era of ferment, framing activities as something helping the achievement of a dominant design when one emerges, and the intertwining of technological frames and organizational architecture in the era of incremental change as one of the reasons why transitions in those periods are so difficult. In this study the focus of the attention is still on individual cognitions, which are considered to be the drivers of technological change, although some implications are underlined about the way individual cognitions impact on collective understanding of technologies insofar they discuss the links between actor's technological frames and interpretative processes, collective technological frames and the evolution of a technology.

A more explicit considerations of a socio-cognitive perception within the study of technological transitions is made by Raven and Geels (2010), insofar they try to explain key steps of radical innovation emergence by adopting a socio-cognitive approach. In particular, they focus on a socio-cognitive explanation of the mechanisms of retention, variation and selection for the diffusion of the innovation. In so doing, they try to show how actions of different agents – being them producers, engineers, users, institutions, ... - are shaped by expectations, understanding, assumptions made by each of them, which guide the way they interpret facts about technology and act in relation to them.

Our discussion of technological memory, which will be made in the following paragraph, builds on these attempts to include cognitive factors in the analysis of technological evolutions, but it will also try to overcome their almost exclusive focus on behavior, i.e. their main consideration of cognitive factors as interpretative tools to explain the behavior of distributed actors in relation to their interpretation of complex socio-technical contexts.

In so doing, we also root our discussion in the foundations of cognitive science, with its attempt to study representational and computational capacities of the human mind and their structural and functional realization in the human brain.

As such, our work is indebted towards seminal works and deep transformations happening in the 1950s at the crossroads of psycology, linguistics, antropology and neuroscience, with the development of new approaches and methods in experimental psycology in contraposition to behaviorism, the foundation of cybernetics (Wiener, 1948) and the cognitive revolution in theoretical linguistics (Chomsky, 1957, 1961), the emergence of computer science and neuroscience with the invention of artificial intelligence (Shannon and McCarthy, 1956; Minsky, 1961, 1967) and the use of computers to simulate cognitive processes (Simon et al., 1958, 1969).

Within this framework, in the following paragraph we will specifically reason about one of the cognitive functions, namely memory, and its implications for technological change and innovations.

4 TECHNOLOGICAL MEMORY AS AN INTERPRETATIVE TOOL FOR TECHNOLOGICAL CHANGE

Memory is a fundamental component of living organisms. If deprived of memory, for example, a living organism cannot find a destination in space, select safe food, tailor its behaviour toward others, perform correctly a learned task beyond instinctive skills, think and act usefully and normally in many other domains and occasions. Cognitive science, particularly neuroscience (Damasio, 2005; Edelman et al., 1992), has recently illuminated many potentials or constraints relating to the individual memory of the living, while the same cannot be said of social memory. Indeed, the very concept of social memory appears problematic and ontologically questionable, both because it is apparently based on nothing more than relations between individual memories, and because it is difficult to be experimented. In fact, a brain injury can be analysed experimentally in a living organism, today, by looking at the decreasing “knowledge-in-action” (Friedman, 1987) abilities of that living organism, whereas a social-memory deficit can not. On the other hand, as explained by anthropology and psychology, this does not obscure the great contribution of social memory in the construction of social organizations in which individual memories are embedded and develop. It is an inextricable link between the living and its social space of life, so important that its primitive absence (or more often a laceration) leads to alienation and the impairment of the ordinary knowledge-in-action abilities (Damasio, 2005).

Commonsense reasoning assumes memory as an important component of ordinary action abilities, but also as a minor component (or even counter-component) of extraordinary creative or action abilities (Weisberg, 1993). Probably the complexity of the memory-part of the brain deceives the common sense here, similarly to what happens in physical sciences when facing highly complex phenomena. Current literature points out how creativity, as an ability of organizationally and ‘combinatorially’ innovating past knowledge, is founded largely on memory (Bink and Marsh, 2000).

Newell and Simon have showed that human problem solving ability links to a cognition-action rule based memory gradually framed through interaction with the real world and education and accessible via an innate program (Newell and Simon, 1972). Anderson has supported the idea of a modular architecture of cognition having at its centre a long-term memory (dualistically oriented towards facts and procedures) and a working memory (Anderson, 1983).

Today, computer science gives a powerful proof of the critical role of memory in all the diverse knowledge-in-action abilities. It emphasizes the role of memory as essential base, together with reflexivity and intentionality (which operate just on individual and social memory), of the development of organizational and combinatorial abilities. The continuous expansion of memory and the increased accessibility to memory – e.g., through the process of multiple indexing (Schank, 1999) – provide even better performance on computers, with very high computing speed that eliminate the processing time of huge chunks of memory in which erudite (rather than creative) reasoning operations are carried out.

A library or an archive are examples of social memory deposits, whereas memorials are examples of physical deposits of individual memory. A civic library can be seen as an example of deposit of social local-based memory, which collects individual knowledge somehow built, developed, stored by individual agents as part of the social knowledge of that local milieu. The lack of a civic library and the presence of merely generic libraries (i.e., the lack of records of local, civic history in that place) makes it complex the reconstruction of knowledge and knowledge-in-action in that place. This is particularly true when those knowledge and knowledge-in-action have been peculiar and have not emulated other general knowledge and knowledge-in-action (Fagin et al., 1995).

The concept of knowledge-in-action makes it possible to avoid the divide between theory and practice, and it looks particularly fertile for the exploration of technologies and their changes. In this case, we are dealing with the physical (but even increasingly virtual) organization of knowledge and knowledge-in-action, which is presumably useful for the preservation and the transmission of a diffused social knowledge. If such a library is missing, yet the place may not be unable to preserve and transmit knowledge. This ability resists in conditions of experiential continuity: but it may annihilate because of great discontinuities induced by complex problems. Such discontinuities may cause those problems to be solvable not merely by using creative individual memories, but also and especially by relying on erudite social memories (Borri et al., 2009).

The concept of technological memory is strictly connected with the above considerations.

In human individual agents, Hofstadter postulates the existence and the need of an "episodic memory", derived from experience. It is essentially built around problem-solving, around the development of episodes and events, and it would be a key deposit for future action and to solve a new problem from the knowledge of the solution to a connected problem. It is a deposit that kids fail to build up in their permanent, long-term memory, so that adults have little or no memories of childhood and related experiences (Hofstadter, 1995). It is a deposit with high value and hierarchical level in the scale of cognitive abilities, so that it is hard to build up automatic reasoners incorporating that ability ("the system must go through its own experiences just as a person does, and store them away for future use") (Hofstadter, 1995).

The conceptual memory evoked in the intelligent software Letter Spirit, built in the 1980s for the design of alphabets artistically consistent, seems to be particularly close to our concept of memory of technological concepts. These technological concepts have a particular social gist in a solution domain of highly complex social and relational problems, which are embedded in local/global chains and situations they cannot exist without (McGraw and Hofstadter, 1993).

The concept of technology and technological change is a highly social concept: within it, memory is essential but it is a social memory, constituted by the interplay of individual memories. Let's consider the case in which an entire generation of individuals, who made a certain technological experience, goes away, leaving a range of technological experiences impossible because of that departure. Then the episodic memory would have no way to activate and could only resist in the individual memories of the next generation, as a 'second hand' wreck of primitive knowledge (or memory). This would in turn cause a decay of memory due to lack of reinforcement, and in further generations that episodic memory might vanish altogether, turning into legend. In this context, the Mexican case studied here is a fair witness of such scenario.

Also the Memory Organization Packets (MOPs) and the Thematic Organization Points (TOPs), postulated by Schank (1982), are directly connected with the concept of technological memory evoked by us.

It is helpful to use a concept of linguistic memory (Schank, 1980) to support the concept of technological memory. In fact, as in technology, apparently also in language an interruption of social abilities (language, local dialect) may occur, so involving the disappearance of one or more generations of speakers of that language in that place. It is like the loss of a living species: if it disappears at all, then we should hope that an akin variety exists somewhere, in order to transplant it and re-activate the lost language. If it does not disappear completely, then a deposit of individual memory can support the reconstruction of other individual deposits and (through interactions) of a social language deposit able to evolve, to adapt, to solve and declare new problems, etc.

As far as our individual agent's memory is concerned, we could speak at a lower level of abstraction about musical memory, mathematical memory, aesthetic memory, sensorial (smell, taste, touch, etc.) memory. They are individual memories, whereas technological memory is a primarily social concept because it refers to an essential apparatus of social resources and cooperations, without which the *techne* on which the *logos* is inserted is impossible, like an ambitious promethean dream.

5 EVOLUTIONARY PATTERNS OF WATER TECHNOLOGIES IN SELECTED CASES

Interesting insights about how technological memories evolve together with technologies themselves and about their individual and communitarian use come from some observations on the evolutions of traditional technologies in very different local contexts, namely in Mexico, India and Italy.

In the Mexican cases[1], we observed the evolutions in relation to a prehispanic technology, jagüey, which is an artificial water reservoir carved in the soil near the hills, where water is diverted through natural or artificial channels. Its use strongly rely on the capacity of local community to maintain it, as desilting of channels and reservoirs as well as proper cleaning of the runoff surface need to take place. The memory of this technology thus include elements of construction, maintenance and use.

A main change in the knowledge-in-action about this technology happened with the arrival of the Spaniards and the colonial period, which produced what some authors have called a "mestizo architecture" (Castro, 2006), i.e. a syncretistic process where previous existent technologies merged with overseas experiences leading both to the introduction of completely new elements like the aqueducts and the renaming and refashioning of already existing devices for water extraction such as wells, aljibes [cisterns], and jagüeyes.

Within this period of breakthrough events, when abrupt changes were introduced within the water field, with the promise to bring abundance and prosperity as well as to ease the use and maintenance of water technologies, technological memory of the specific jagüey technology underwent deep modifications. A survey was made to understand the prevalence and use of jagüey as a main water source for small rural Mexican communities and the main features and diffusion of technological memory within two villages in Mexico, namely San Antonio and San Martín in the State of Puebla (Torregrosa et al., 2010).

This survey revealed how that technology and its memory persisted and reproduced across time only when they represent a culture in action, i.e. they are part of culture and everyday life. In particular, although jagüeyes generally tended to disappear in Mexico as water coverage due to piped water or other modern technologies increased, significant differences were noted in the two cases. In particular, in the case of San Antonio an important fraction of the male population was found to still understand and be able to reproduce the technological principals at the basis for the construction of the jagüey – at least in theory as most of them never constructed a jagüey. On the contrary, in the case of San Martín the chances of reproducing this technological system are scarce, the only knowledge remaining is related to the maintenance tasks and not to the technological principles for its construction.

These difference were explained with two factors, which are related to the way technological memory was built and the way it is currently linked to knowledge-in-action. In relation to the origin of technological memory, a key difference comes from the fact that while in San Antonio the jagüey was built at the beginning of the twentieth century by grandparents of current village dwellers, so that these have a strong

1 Case studies in Mexico were analyzed within the research project ANTINOMOS, "A knowledge network for solving real life water problems in developing countries: Bridging contrasts", funded by the European Commission under the Sixth Framework Program, thanks to the joint efforts of the international consortium and field research made by the Latin American Faculty of Social Sciences (FLACSO) team (Maria Luisa Torregrosa, Karina Kloster and Jordie Vera).

memory of the construction of that technology as it was linked to stories told in their childhood and to names of people they perfectly know as previous members of the community, in San Martín, local dwellers obtained that technology through land endowment in the 1940s, so they did not build it and do not have any memory of its construction (Torregrosa et al., 2010).

Secondly, it's worth mentioning important differences in the actual use and reproduction of that technology in the two villages. In San Antonio jagüey recently underwent a process of innovation and change as a small dam for reducing silting of the system and a biofilter to increase quality of water taken from the jagüey were recently constructed thanks to the support of the federal government and the cooperation of villagers. In so doing, local dwellers reinforced their knowledge about the system and their memory about its use through individual and collective actions for the evolution of the system. On the contrary, in the case of San Martin, where the population has grown and differentiated, the introduction of piped water has carried along the disuse of the jagüey for human consumption. In this case the culture in action in correspondence with the use of the jagüey and its memories are disappearing.

In India we observed the evolution of water tanks, which constitute a traditional and widespread water storage system for individual and communal use in urban as well as in Templar complexes. They were traditionally built underground, with retaining walls made of bricks or local stones and held together by silt, and were receiving rain water from roofs and terraces through a system of copper gutters and downspouts. They had a small opening on the roofing from which you to draw water with buckets.

The evolution and memory of this technology was observed in the old city center of Ahmedabad, in the Gujarat State, where large tanks with an average storage capacity of 25.000 lt had been built in the past. A survey made by the municipality showed a huge diffusion of this system, with the presence of about 10.000 cisterns within the old town, out of a total of about 70.000 houses, although more detailed investigations carried out on the site allow to assume the presence of an even greater number of tanks (AMC, 2000; Grassini, 2003). They were mainly individual systems, directly put under the premises of each house, with the opening in the internal courtyard of the house, in the near vicinity of the kitchen.

A main breakdown in the knowledge-in-action of this system happened between the 1940s and 1950s due to several events. On one side, the order of the British government to seal those systems at the time of the Indian struggle for independence, in order to avoid that they could offer shelter to any rebels (AMC, 2000). On the other side, the beginning of piped water supply through the newly built aqueduct system within the city, which took place in the 1950s and led to the definitive abandonment of these ancient systems in favor of a system, which was conceived of as more efficient and not needing any individual nor communal effort for maintenance.

As a consequence, at the beginning of 2000 all tanks within the old town were not in use, and a vast majority of them were strongly compromised by their recent use as damp sites. The memory of that technology was very superficial within the community as they did not have any link to knowledge-in-action neither in relation to the construction nor to the maintenance needed to ensure that only clean rain water could be stored and kept of a good quality.

Despite these limitations, at the beginning of 2000 a pilot project started for the rehabilitation of 11 tanks within the old city center, with the aim to demonstrate the re-use potential of those systems. It was indeed a top-down and elitist project, which was promoted by a cultural association guided by the State Ministry of Health, which was himself a resident in the historic center, with 100% funding from the Heritage Cell of the Ahmedabad municipality. The project thus resulted in a mere rehabilitation of the physical structures of the old technology, which was completely detached from any change in the broader socio-technical system and in the technological memory held by local community. Technological memories and perceptions of this technology remained completely unchallenged by the project, thus rehabilitation did not make any substantial change in the deep understanding of water technologies within key local actors.

The last case under scrutiny is related to deep technological changes produced in the water field in the Apulia region, in Southern Italy, in the last Century. The history of water management in this region is the result of a complex interplay between a slow evolution of traditional techniques and breakthrough events of deep technological change, which erupted at the beginning of the XX century with the construction of the current largest aqueduct in Europe.

The construction of this titanic engineering effort, which attracted attention from all over the world and made Apulia suddenly start its run towards progress and modernity (Viterbo, 1954[2010], Masella, 1995), created an abrupt break between past and future. This was done, on one side, in terms of physical infrastructures, as the spreading pipelines were rapidly leading all traditional techniques, mainly based on rain water harvesting (especially underground tanks in urban areas as well as in rural contexts), to disuse and collapse. But this also had important implications in terms of deep perception of water and its use by the local population as far as it made local people believe that technological change could definitely free them from scarcity and from the old thirst, beyond any environmental limits and foreseeable constraints, and let them forget their backward past to embrace prosperity and progress. In this idea, technology became a sort of black-box, a saving tool, whose construction and functioning was fully devoted to engineers and technical people. This quickly led to a decay, among local people, of technological memory about traditional water use and techniques, and made them embrace new practices and patterns of water use derived from a concept of water as abundant resource (For a more detailed account of the evolution of water technological systems in Apulia and their interpretative process see also Grassini (forthcoming)).

An analysis of the processes which made this change happen and its wider consequences in terms of the conception of technical progress and changing relationships between local communities and the environment showed how the different conception of technology and its role for progress produced deep changes not only in the way people related to new – imported – technologies, but also in the way they used traditional technologies – whenever they persisted and did not go defunct, like in the case of wells. While in the past their use had been mainly related to subsistence and individual purposes, the diffusion of mechanized systems for water extraction made that technology become one pillar of the widespread attempt to guarantee abundance of water for modern production systems.

The idea that the rise of the water supply was an undeniable right, especially for the population of a region that had long suffered from lack of water, and the underestimation of the impact that the spread of modern techniques for water extraction from underground aquifers could have on aquatic ecosystems led to subsume completely those technologies and their functioning within the newly imported socio-technological regime. This is a well known mechanism related to knowledge evolution in contexts where traditional knowledge merge with other knowledge systems giving rise to several combinatorial possibilities: primary-level practices and facts learned from external knowledge may be subsumed under secondary-level interpretative concepts from pre-existing systems; conversely, newly-acquired secondary-level concepts may be adopted to explain practices of the existing systems (for an interesting account of this mechanism in the case of tree management technologies in India see Brodt, 2001, 2003) or, as in the case of the Apulia region, re-organize existing practices to new aims and purposes within new socio-technical trajectories of change.

6 CONCLUDING REMARKS

We have evoked the concept of TM starting from evidences presented by some case studies of water technology in environments in which traditions and memories still resist to innovations and standardizations. Meaningful cases are the water technology of the Mexican jagüeyes, the Indian tank systems and several traditional technologies observed in Italy, whose actual persistence or interruption is due to complex and multifaceted processes of technological evolution. In those cases, micro-learning processes and the distributed inputs of a multiplicity of agents collide with breakthrough events suddenly imposed by conquerors or by modern science. Since the ancient ages, in arid climate countries, water technology presents extraordinary examples of specific organizations devoted to designing, constructing, and managing complex and ambitious works. The gradual minor adjustments that have been brought to the original forms of these works through infinite replications in different places and times suggest that social forms of cognitions and actions interacted with individual contributions, granting a blend of mutual learning and transfer of memory and creativity.

With the gradual disappearance – for many reasons – of the productive and market organizations on which certain techniques are based, technological memories referring to them begin to suffer transformations and sometimes become unusable. One such example in the field of architecture is related to the construction of large roofings in the Roman Empire. While in Rome during the Empire age a semisphere of more than 40 metres of diameter was built for the Pantheon's dome in a very sophisticated way with extremely light prefabricated clay pieces settled in concentric circles and linked by high resistance and extremely light mortar, covering large spaces without intermediate supports became impossible for the next 1.500 years, until the reinvention of a different building solution (much less sophisticated: heavy masonry, made of bricks reinforced by big ribs) with the Gothic dome designed by Filippo Brunelleschi for the cathedral of Saint Mary in Florence (Petrignani, 1978). In this case, the disappearance of the Roman political and productive organization operationally annihilated a technological memory. Building history and techniques in exceptionally wide perspective were presumably perfectly known by Filippo Brunelleschi in Florence or by Andrea Palladio in Venice: the two giants of architecture presumably shared the sectoral TM which was needed for emulating the Roman technique of covering large spaces but they did not have anymore the ability of making it operational.

In the light of the above simple considerations, thinking on one side to the Newell's and Simon's memory model (abilities as gradually formed by series of condition-action rules) (Newell and Simon, 1972) and on the other to the Anderson's one (factual memory plus procedural memory) (Anderson, 1983), the idea is that TM is labelled in relation to its own essential attributes like facts, procedures and judgments. Then it becomes clear how parts of TM learnt through experience within a tradition, or through descriptions from others, can be gradually abandoned till the eventual cancellation or be more probably qualified with obsolescence and impracticability attributes.

Let's come back again to the difference in TM between the big Roman constructions and the constructions built in the ages to come. Perhaps the giants of technique and creativity in the Western world ignored some operational details of those constructions, for example the preparation of special pieces and mortars, and therefore they could not design them even if hypothetically they belonged to a still practicable activity. As a matter of facts, individual memories make sense not per se but within social chains of context-based practicability, they are made by transmission rings cut and interrupted by disappearance of individuals, organizations, resources, and examples (Severino, 1988).

As a consequence, TMs are constituted in the agents through direct or indirect (i.e., diffused outside from local origins) experience, and can:

- (i) be limited to simple passive cognition of facts and procedures ("I know that a certain technique exists" or "I saw that technical device while functioning", or "Somebody described to me that technical device but I never had a chance to use it") or
- (ii) become part of an active inclination of the agent as a direction given by him/her to other agents (political agents can tell other agents to adopt that technique: they have to learn it immediately, if they do not know it yet), or, further,
- (iii) become part of a life that uses that technique ("I am a user of that technical devices, should they have functionality problems I should be able to repair them" or "I saw that technical device functioning, while giving me water availability for long time", or, in the end,
- (iv) become active ability ("I very well know that technical device as I had the chance to build it" or "I was present when this technical device was built and started its functioning" or "I know how to create this type of technical device here", or "I am a user of this technical device", or "I am not a user of this technical device but I could be a user of it in the future").

In a process of technical imitation, consisting in introducing an exogenous technique into a place, we witness a process of technical change, where an ecological variant is built. Its inspiring principles (ontological concepts and relations) remain substantially fixed, although they are linked to the way the imitator conceptualized that technique or to the way that technique was represented to the imitator (through a technique description by an informed agent). Therefore in technological transfer and use of TM it is important to distinguish general principles from local applications.

TM, in our view, cannot be effectively constituted, however, when the principle of functioning and applicability of its components (techniques) is not enough clear in detail. In this case, the techniques are not memorized or are destined only to passive action memories, and commonsense warns us against their possible superficiality and political orientation ("Use that technique, it has a lot of positive credentials!"), in that it can prove to be a disaster because of a too scant knowledge. So our answer to the question if TM is a particular form of memory or it complies with the dominant model of generic memory currently postulated is that operational TM is constituted by facts and explanation about facts from which actions come down: it is not a mere if-then-type memory of events and of phenomena in which causal relations are relaxed.

Furthermore, TM is constituted selectively. Selection has large stitches when human agents perceive by intuition that a large filter is essential for them, because capturing more technical memories increases their survival abilities in the future inevitable solitary confrontations with those technical problems. Selection has narrow stitches when human agents perceive by intuition that even if they do not understand those technical problems they could delegate the problem solving to others (see the Nozick's hypothesis about the emergence of a technical rationality more and more inaccessible for non-specialists) (Nozick, 1993).

In all cases examined in this paper, the construction of technological memories within local communities can help explaining the difference in the performance of technologies and in their actual evolution and use within different contexts. In the Mexican case, for instance, we have a water technology, the jagüeyes, which presents a problem of TM tragedy in a village community under the push of exogenous innovations (water engineering of the Spanish conquistadores vs water engineering of the Mexican natives). In one case,San Antonio, TM was diffused in the whole set of community agents and linked to knowledge-in-action abilities, so that the whole society of the individuals of the village contributed to maintain the jagüeyes and became active protagonists of that technique and agents of the related TM; in case of San Martin, TM never constituted an active ability but was mainly restricted to passive cognition of facts and procedures, eventually leading to the collapse of the system. The spread of TM within the first village also explains the capacity of those villagers to adapt the ancient technology to their new needs, thus having the old components of the technology as source of innovation and technological change.

This would also confirm the concept of cognitive difference between passive or active participation in practicing a technology. In all cases we examined, innovation potential proved to be very closely related to the persistence of technological memory, which constitutes the roots of technological trajectories of innovation and change, like in the Mexican case of San Antonio. On the contrary, where memory vanished local communities proved to be unable to have any role in innovation processes and became only passive recipients of externally induced technological changes, which were mainly condemned to failure as in the Indian case.

NOTES

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LEARNING AND SHARING TECHNOLOGY IN INFORMAL CONTEXTS

A MULTIAGENT-BASED ONTOLOGICAL APPROACH

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ABSTRACT

An increasing debate is growing today, in both academic and research-in-action contexts, about the roles of new and traditional technologies in raising knowledge of agents involved, as well as in boosting an effective development of communities.

The last century has been largely dominated by capital-intensive technologies, impacting large and populated areas. From the late 1990s up to the present days, due to social, financial, environmental concerns, new low-impact, local-born, little to medium-scale experiences have been challenging large technologies, with interesting results.

The importance of such experiences seems to lay on the abilities and knowledge of local populations, which are quite difficult to emerge as formal methodologies and attain recognizable levels of generalization and sharing. Yet the effectiveness of local-based technologies is being increasingly documented, often succeeding in cases where more formal technologies had previously failed.

The EU-funded ANTINOMOS project has largely dealt with local-community knowledge enhancing and managing in the water sector management, aiming at creating a real learning environment for the sharing and the active generation of knowledge through mutual synergies.

In this paper, the above subject is discussed and carried out with a cross-disciplinary, cross-scale, multi-agent approach, considering the different forms of local knowledge and language involved.

KEYWORDS

Water resource, Technological memory, Learning architecture, Semantic navigation, Ontological indexing

1 INTRODUCTION

Nowadays the self-reinforcing circular relationship among engineering technologies, education, and engineering educational technologies is gaining considerable momentum both in production and research environments. In particular, debate is growing, in both academic and research-in-action contexts, about the roles of new and traditional technologies in raising knowledge of the agents involved, as well as in boosting an effective development of neighbourhoods and communities.

In the second half of the past century, structures and infrastructures – particularly the publicly managed ones - have been largely dominated by capital-intensive technologies, impacting large and populated areas. From the late 1990s up to the present days, due to social and financial difficulties, as well as environmental concerns, new low-impact, local-born, little to medium-scale experiences have been challenging large technologies, with interesting results worldwide.

Far from being connected with technological innovation per se, the importance of such experiences seems to lay on the abilities and knowledge of local populations, which are quite difficult to emerge as formal methodologies and attain recognizable levels of generalization and sharing. Yet the effectiveness of local-based technologies is being increasingly documented, often succeeding in cases where more formal technologies had previously failed.

Given this situation, governments have approached the emergence of such informal experiences with mixed attitudes, ranging from reluctant or even contrasting actions, to more proactive and encouraging support. European Union acts with a proactive and financial support achieving interesting results, and the Technical university of Bari has been deeply involved in the ANTINOMOS project.

This project was funded by FP6 for Research and Technological Development set up by the European Union under the “Sustainable Development, Global Change and Ecosystems" thematic priority. It was a prototypical example of a process stemming from diverse loops that show a certain degree of “reflexivity” among the project components, being: a) managed by a consortium of partners from different countries; b) interdisciplinary; c) aimed at contributing to global and local knowledge networks for the solution of real life problems in water supply and sanitation in developing countries; d) meant to bridge conflicting views (of conceptual approaches or perceptions of global and local knowledge networks) and knowledge gaps (among the knowledge areas which have only recently been recognized by decision makers as being key issues in achieving the Millennium Development Goals).

In particular, a large part of the ANTINOMOS project has dealt with knowledge management, with the threefold aim of providing stakeholders with (i) access to relevant, timely and easy-to-understand information, (ii) the ability to use such information to take decisions leading to an efficient and effective project implementation, and (iii) a real learning environment, able to allow not only the passive sharing of established knowledge, but also the active generation of novel knowledge through synergies.

Within this project, the role carried out by the Technical university of Bari is interestingly consistent with the management, exchange and increase of knowledge among partners and beyond. According to the project mission, the building up of multiple-agent system architectures is a primary objective, aiming at eliciting, collecting, sharing and promoting local-based technologies among multiple users worldwide.

However, the collection of relevant knowledge from global and local technologies and practices entails a complex cross-disciplinary, cross-scale, multi-user learning environment, able to facilitate the generation of knowledge and to process multiple-source information into significant knowledge for the agents involved. This means that different forms of local knowledge and languages, coming from expert and commonsense domains, need to be decrypted and then rearranged and tailored to the different needs of distributed agents. Research experiences in this context are scanty, because of the inherent complexity of large knowledge management with different formal and informal languages – hard to be dealt with in system architectures. The approach of the Technical university of Bari research is rooted in computer-science reflections on agent and multi-agent cognition, as well as the identification, discussion and setting up of platforms to support learning exchanges.

The paper is structured as follows. After the present introduction, chapter 2 carries out a brief account on the knowledge aspects of water technologies, with particular reference to the ANTINOMOS project. Therefore, some notes on multi-agent cognition and the role of ontologies in learning system architectures are drawn out in chapter 3. In the fourth chapter a framework discussion on the concept of technological memory and its formal aspects for efficient indexing search is carried out. Finally, chapter 5 deals with the current aspects, potentials and follow-ups of the learning system architecture, followed by final remarks in chapter 6.

2 LOCAL AND GLOBAL WATER TECHNOLOGIES AND KNOWLEDGE

The system architecture described in this paper has been set up within the framework of the EU funded project ANTINOMOS, “A knowledge network for solving real life water problems in developing countries”. The overall project strategy starts from the conviction that inadequate knowledge management is at the roots of the present obstacles to solve real life water problems in most developing countries. Although the intrinsic complexity of socio-technical relationships in water field started to be recognised only very recently, current practices in the field still suffer from enduring divisions and sectoral thinking (Latour 1987; Bijker 1997). In this situation, boundaries across different forms of knowledge and disciplinary approaches hamper more holistic understanding of water problems and the capacity to link knowledge to action in most real life contexts.

This is very clear in the conflict between modern technologies and traditional ones, which is part of a larger opposition between the knowledge systems in which those technologies are embedded. While mainstream international interventions are still mainly devoted to transfer modern western technologies to developing countries, local contexts are mainly seen as limiting factors for an easy transfer of external solution instead than a source of useful knowledge for water problems. In this vein, traditional technologies and practices are still often perceived in the mainstream water science as based on irrational belief and myths, thus being subjective, context-specific, and lacking a sound cause-effect basis (Millar and Curtis 1999). They are considered to be the product of a non scientific system of thought, which should be “modernized” through the transfer of other systems of thought. Kloppenburg, for instance, used paired concepts to distinguish the so called Western from non-Western ways of knowing like scientific versus practical, explicit versus tacit, abstract versus concrete, rational versus intuitive, masculine versus feminine, science versus craft, absolute versus relative, scientific versus indigenous (Kloppenburg 1991).

In reaction to this critique, several researches started from the Seventies and then mushroomed in the Nineties, which assert the importance of indigenous knowledge as a system of thought embedded in traditional technologies and practices and their scientific basis. At the same time, several attempts were made by activists and researchers for the rehabilitation of traditional water technologies and practices as a viable alternative to modern technologies, whose ecological and social costs started being increasingly recognized (Escobar 1995; McCully 1996; Postel 1998; Guha 2000). This had important theoretical and practical implications. Theoretically, it helped to relativize moderninst rationality by suggesting that there were equally valid ‘native’ points of view. On the political side, it contributed to challenge the assumption that rural poor were somebody else's development strategy, and the subjects instead of the active originators of their own patterns of development, so giving strong emphasis to a large literature on political ecology (Escobar 1996; Peet and Watts 1996; Braun and Castree 1998). Nevertheless, these experiments also led to the construction of an alternative orthodoxy based on an idealistic picture of indigenous people (Baviskar 1997) and to an exaggerated critique of technological modernization. This reinforces instead of reducing the paradigmatic conflict between modern and traditional approaches to water technologies.

Starting from this situation, our project tries to see if the possibility exists to bridge these antinomies and to define a learning space among them. In this way it tries to see if a reframing of water problems is possible in such a way that new knowledge can be generated and new solution spaces opened. In so doing, knowledge would not be simply summed-up across disciplines and boundaries, but it will become input of a much larger process of knowledge development. Knowledge itself would be created as a result of synergies among different "knowledge workers" interacting through new learning spaces (Drucker 1999). This is line with results from the application of open source philosophy, which successfully managed to share knowledge and partial solutions as a starting point for the generation and enrichment of knowledge itself through the interaction of individual actors.

The possibility to create these synergies indeed depends on the capacity to structure appropriate learning spaces where multiple actors can interact in a meaningful way. This is not easy to do, as their knowledge may be embedded in very different knowledge systems, depending of their disciplinary backgrounds – which entails the use of different taxonomies and knowledge frames – the geographical belongings – which entails different knowledge labels and different languages – and different scales – which also means different levels of generalization of concepts. Different actors may indeed belong to different "knowledge communities" (Nonaka 1999), all defining shared codes and jargon for internal communication and rules for sharing information and knowledge. The definition of real learning spaces thus requires strong attention for the development of appropriate cognitive architectures which are able to bridge the gaps between formal and informal knowledge and between global and local contexts, which are still often separate in practice. This necessarily means to single out appropriate knowledge workers and knowledge areas to involve, to create an appropriate structure for learning bridging structural divides between knowledge areas, to link knowledge to action in an action-research perspective. This is what we tried to do with the system architecture described below.

In this system, knowledge about different types of modern and traditional technologies for water supply and sanitation has been structured based on the analysis of their overall performance and on in-depth investigations aimed to assess critical factors for their success or possible reasons for their malfunctioning or bad use, including institutional and organizational issues, socio-economic and socio-cultural issues, hygienic/health risks and environmental consequences. Technologies analysed are from three countries, namely India, Mexico and South Africa.

3 ONTOLOGICAL APPROACHES FOR KNOWLEDGE INDEXING IN MULTI-AGENT ENVIRONMENTS

The setting up and management of social facilities for the development of local communities is increasingly relying on a multiple-scale level of infrastructuring technologies. From large-scale projects serving large parts of anthropic environments to small plants for villages or even households, infrastructure provision appears to be increasingly tailored to different and often non-connected levels of use. However, while large projects leave enough –at least formal- knowledge repositories for technology outreach, small projects often remain obscure, relegated to a localized and limited use, although being at times successfully implemented in everyday life. Furthermore, due to multifarious – economical, orographic, political/organizational – difficulties in providing all communities with large-scale infrastructuring, small communities remain substantially dependent on local technologies.

Yet when dealing with small and isolated and/or mutually unconnected (e.g., in information and knowledge exchanges) communities, particularly in developing Countries, technologies have difficulty in spreading in time and space, so resulting in ephemeral, discontinued, unreplicated, or inefficient, and many times unsuccessful experiences. Some case-studies literature, particularly in the fields of water provision and sanitation, seem to recognize complex technological knowledge/expertise gaps behind that situation, in building up as well as in managing and maintaining technological infrastructures (Unver 1997; Torregrosa Armentia *et al.* 2006). Acknowledging such complex problem leaves nonetheless space for specific research on narrowing gaps and bridging them by relying on knowledge enhancement and learning environment, able to allow the sharing of established knowledge, as well as the generation of novel knowledge through mutual synergies.

The potentials of IT-based knowledge sharing approaches in local development initiatives have been long debated in literature over the last few decades, focusing on an increasingly large number of positive results mixed up with some criticalities (Borri *et al.* 2005; Borri *et al.* 2010b). Particularly in Developing Countries, the use of large-scale information technologies faces political and demagogical –more than technical and literacy- constraints whose resulting informational asymmetries are beneficial to few corporative agents to the detriment of the general population (Greenwald and Stiglitz 1986, 1990). However, the large real-time, multi-agent, multisource interactive approach is able to set up capillary knowledge networks and learning environments potentially rather effective.

The experience gained in the last years has shown some critical aspects that such initiatives should take into account, when trying to set up operational environments (Khakee *et al.* 2002; Borri *et al.* 2006a). Some important aspects can be outlined in this context as well as in general terms.

(i) A first general issue faced by IT-based interaction systems is well known in organizational studies, and concerns the real possibility for end users of accessing the system, particularly in poor communities. Low possibilities mean delegating access and feedback to selected agents who represent the community, so raising problems of legitimation and representativeness with reference to the community itself. Also, representative agents may even unconsciously filter interaction outcomes, so raising problems of misunderstanding, mystifications and generally poor levels of knowledge transmission to the community (Forester 1988, 1999). Methodological and architectural approaches aimed at facilitating and expanding the access and interaction potentials of all agents could substantially lower the above problems and enhance the effectiveness of knowledge transmission efforts.

In building up our IT-based learning environment oriented to water-resource technologies and issues, an initial knowledge base coming from ad-hoc studies represents the starting point to share (and to build on) cognitive contents among participating agents. Structured as a plain hypertextual document, the initial repository is supposed to be navigated, modified, integrated and acquired cognitively by agents through a dynamic web portal, toward the definition of a complex self-evolving learning environment.

(ii) When focusing on system building up, another important issue deals with the question of idioms and access languages, particularly in knowledge indexing to perform research and navigation features throughout documents (Khaled and Mohamed 2004). In fact, some types of agents such as scholars, professional agents, experts in scientific disciplines rely on formal domain languages and vocabularies in web searching tasks. In this case, document structuring to enhance search options is a relatively easy activity because search tags are formalized, and the whole knowledge navigation/sharing is a rather straightforward task –at least in simple queries (King and Munson 2004). Yet less expert agents need a commonsense and less formalized approach, largely based on concepts, sentences, periphrases and syntagms (e.g., searching techniques to obtain less 'stinky' water, or techniques to maintain devices 'more easily', etc.). Actually, the same concept-based approach may well be claimed by expert agents when performing more multifarious and composite research tasks. These agent categories entail easier and/or fuzzier approaches to navigation, and need consequently more complex document indexing in the system architecture, in order to allow an effective contribution to the learning environment.

(iii) A further important issue faced by the IT-based interaction system deals with agents' cognitive frames involved in the navigation task. In fact, according to consolidated branch literature, each agent involved in interactive reasoning activities shows different cognitive patterns and organization in carrying out their knowledge-based tasks (Shanahan 1997). Case studies show that the frame problem influences the cognitive agents' ability to navigate without losing themselves in huge 'problem spaces'. Framing is used for context-based and case-based pruning of dangerous and unfruitful regions of those spaces, particularly when the number of knowledge agents is large – such as in web-based multi-agent environments (Borri *et al.* 2004). Also research tasks are affected by the frame problem, inducing differentiated indexing approaches on knowledge memories and repositories for effective navigation. In this concern, allowing a more flexible, fine-tuned, semantic-oriented research indexing seems more suitable to address different agents' cognitive frames than synthetic and taxonomic tag indexing.

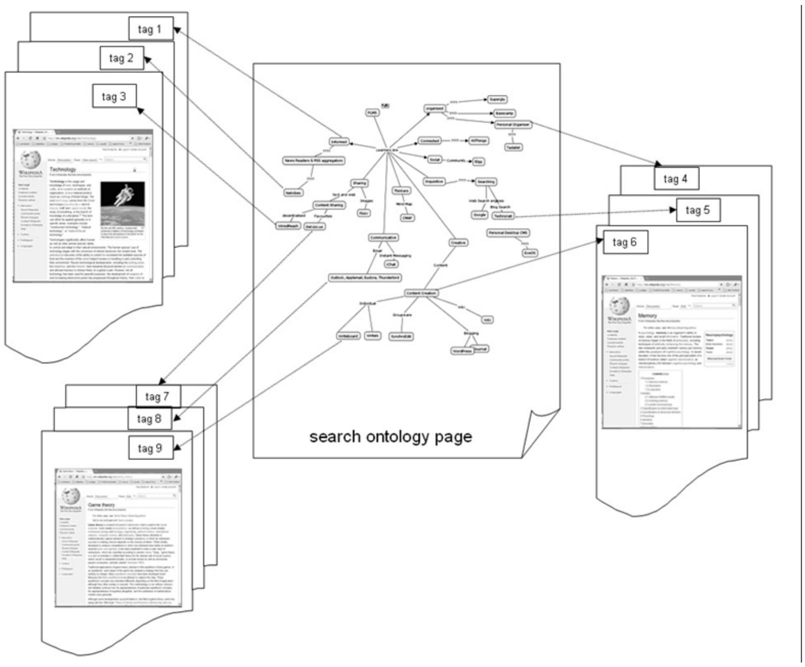

Fig. 1 An example of the ontology-based indexed search

(iv) When getting on with navigation search, agents may infer hints for new indexing criteria from the interaction with other navigating agents and from the substantial results of the ongoing navigation itself. The search activity itself may suggest new concepts that can be used for further navigation fine-tuning and for achieving access to new aspects of technology knowledge. If the finding out of new navigation criteria highlights a structure of relations among concepts, then the search task may lead to ontological structures of interconnected criteria to be used as dynamic indexing frameworks for subsequent navigations. The ontological indexing can be defined as ‘dynamic’ if it evolves during the navigation/interaction activity: if the system is able to keep trace, memory and ongoing updating of the indexing modification, then a self-learning ontological indexing system results, similar to self-feeding engineering intelligent systems, with an ontological approach (Abraham and Grosan 2008).

From the above considerations, it could be concluded that ontologies are useful in setting up indexing systems to support navigation tasks in learning-oriented environments. Yet many of the features proposed require large reference to ICT-based devices and computer-science approaches that are pretty far form the scope of the present study. In the following chapters an account will be made of the activities carried out by the study group to set up a web-based interactive learning environment, with particular reference to semantic-based search indexing and their ontological perspectives.

4 THE WEB-BASED INTERACTIVE LEARNING ENVIRONMENT

In the creation of the knowledge management system (KMS), the above general issues are added with needs more directly linked to the research project itself. After a first stage of the actual project, with mainly research and academic aims, a second “distributing” and “organizing” stage has follow, aimed at using information by local communities in different developing Countries (fig. 2).

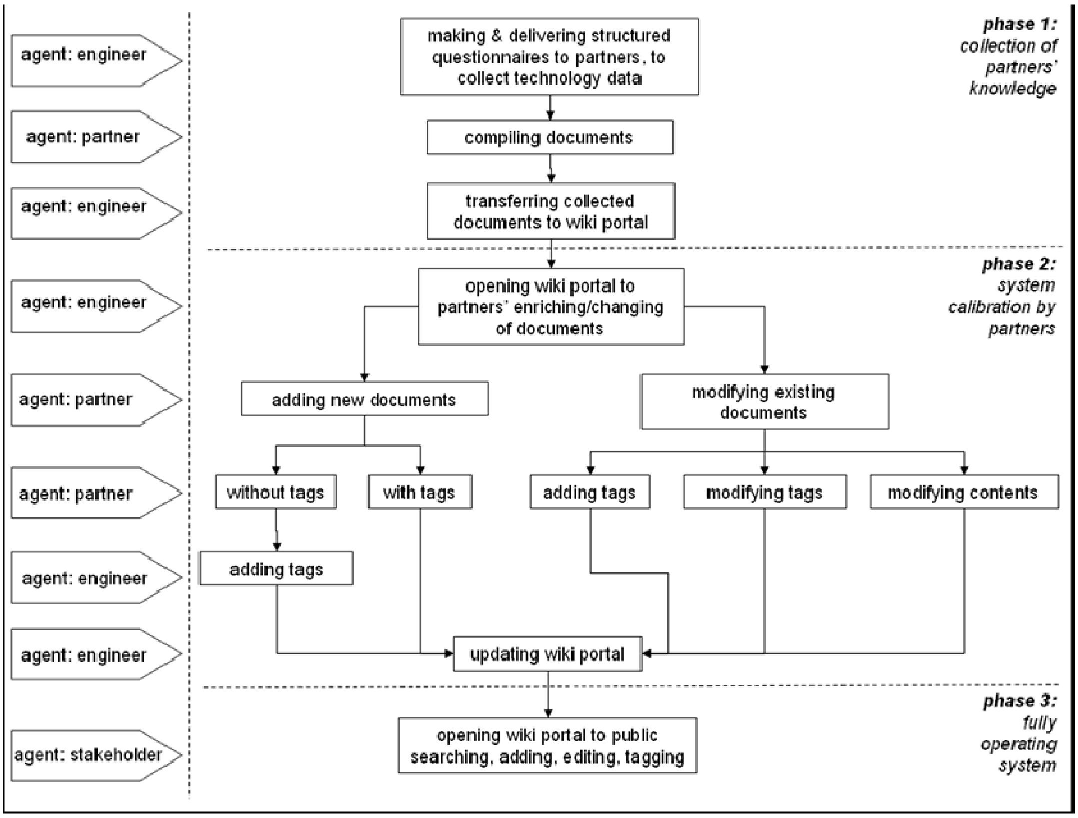

Fig. 2 Stages and agents involved in the building up of KMS

In the first stage, the group of users is mainly made up of author-type agents and is relatively not large. The needs to be satisfied by the system are especially connected with partners’ belonging to different disciplines and Countries.

In the second stage, the group of users is much larger and is mainly made up of reader-type agents. The group needs to be registered and submitted to a board which controls newly published and/or modified information. The requirements to be supported by the system are especially related to the connection of global and local networks, to the possibility of filling knowledge gaps and to the ability of facilitating the solution of possible vision differences on subjects at hand.

Transversely to the first and second stage of the project, other characteristics are needed by the KMS. They are the access to remarkable, real time and easy understandable information, the possibility of using such information to take decisions, the creation of a real learning environment able to allow not only passive learning, but also new knowledge generation.

Therefore, from a basic architectural standpoint, the classic LAMP (Linux, Apache, MySQL, PHP) was the solution stack used. The selection of this environment was due to some well known advantages, such as open source code, large user-community support, easy-to-code, easy-to-deploy and develop-locally features, cheap and ubiquitous hosting (Gerner *et al.* 2006).

Also, it was decided to use a collaborative web-based knowledge-sharing software under the so-called 'wiki' category. In particular, the "MediaWiki" software was selected, added with the 'semantic MediaWiki' extension. Its selection was due to some useful characteristics, namely the easiness of creating and editing a very large number of web pages through a browser, using both very simplified markup language and WYSIWIG text editor. Most of the cost of processing (usually very low in the case of wikis) is almost entirely server-side supported: from the client side, a standard, not even last-generation web browser is required (Ebersbach *et al.* 2008).

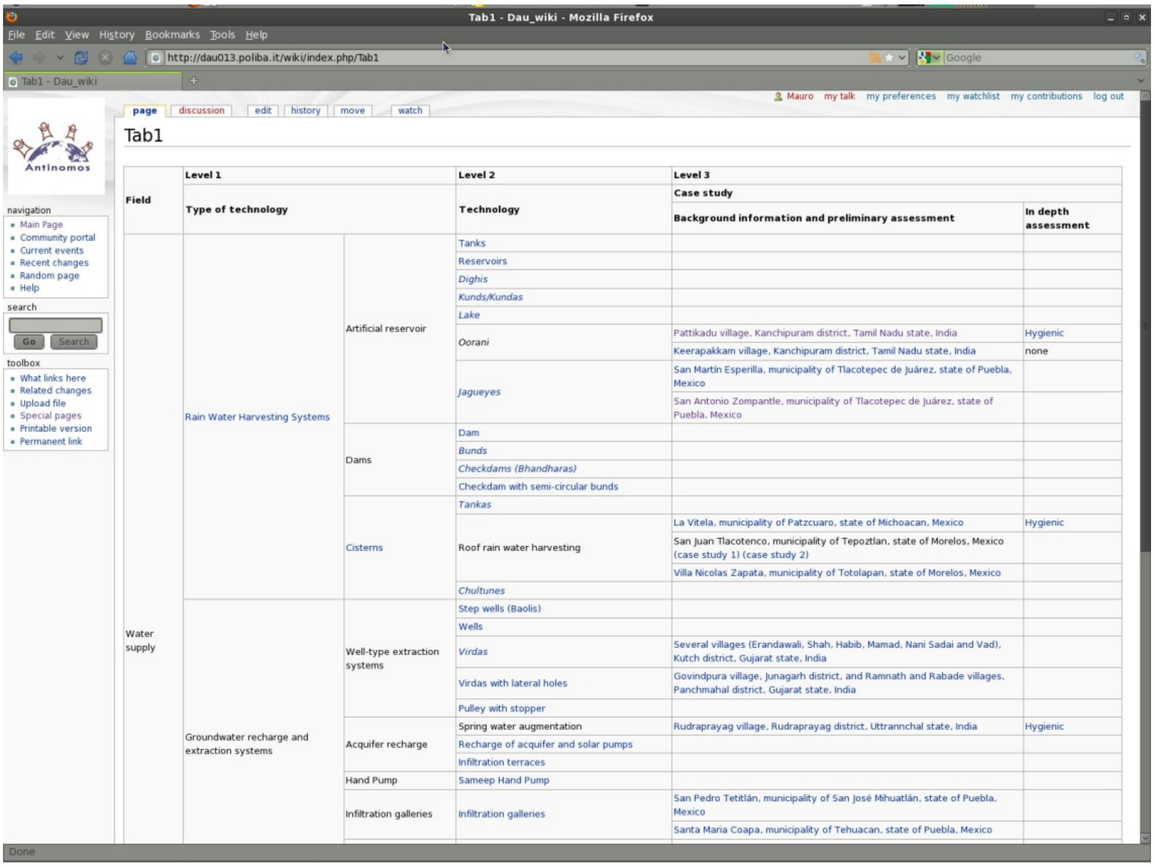

Fig. 3 The ANTINOMOS wiki portal

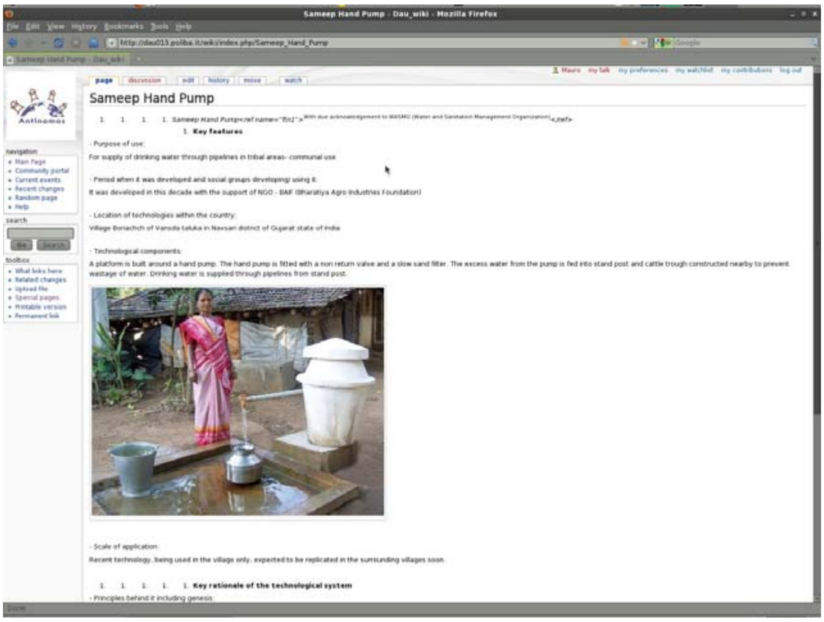

Fig. 4 An example of water supply informal technology

The main idea is to create a KMS with the possibility of being strongly collaborative and community supporting. On the other hand, having the system to deal with a particular subject, then publishing rights should be guaranteed, either to have control on any off-topics, or to safeguard the intellectual rights of different authors.

The need of organizing databases according to different meaningful topics is satisfied partly through the possibility of creating associations among different web pages via hyperlinks and partly through the markup system of the semantical extensions installed.

The fundamental idea is to set up an ongoing process of creation and collaboration, able to change the website 'cognitive landscape' from the standpoint of both the stored raw datum and the classification meaning of information in its entirety and complexity. The attempt is to create a cooperative system of information management, strongly oriented to easing creation, navigation, search and, last but not least, attribution of meaning.

Some features of the website are native characters of the non-linear navigation support of wikis. In that context, users may create links, indexes, tables reflecting any form of organization of information they prefer. However, a more structured form of content organization is being implemented in the website, framed on semantic extensions and ontologies. The completion of such structuration is a particular task of the EU-funded research project and represents an interesting research perspective in developing multi-agent technology learning environments in informal contexts.

5 BRIEF FINAL REMARKS

The present paper dealt with the importance and the perspectives of the multi-agent learning and sharing of water technologies in informal contexts, within the EU-funded ANTINOMOS project. In particular, the setting up of system architectures to support learning and knowledge interactions among diffused agent has been investigated, using web-based models and technologies. In this context, knowledge exchanges and technology learning are supposed to be highly dependent on the quality of the interaction environment. Therefore, the study has devoted a particular attention to the structuring of the searching and navigation features of the system, heavily highlighting the quest for efficient indexing approaches.

To this aim, the importance of semantic navigation has been emphasized, and the quest for searching features has been oriented to the potentials of ontological indexing, as a base to allow semantic tasks.
At present, the study work is still at an early stage of complex yet traditional web searching tasks. This paper has showed some aspects of current features, also presenting the funding rationale, some potential and criticities of the next semantic-based learning environment. The development of the system architecture of that environment represents an important legacy of research activities started off with the ANTINOMOS for the future.

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SMARTNESS AND ITALIAN CITIES

A CLUSTER ANALYSIS

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ABSTRACT

Smart cities have been recently recognized as the most pleasing and attractive places to live in; due to this, both scholars and policy-makers pay close attention to this topic. Specifically, urban "smartness" has been identified by plenty of characteristics that can be grouped into six dimensions (Giffinger *et al.* 2007): smart Economy (competitiveness), smart People (social and human capital), smart Governance (participation), smart Mobility (both ICTs and transport), smart Environment (natural resources), and smart Living (quality of life).

According to this analytical framework, in the present paper the relation between urban attractiveness and the "smart" characteristics has been investigated in the 103 Italian NUTS3 province capitals in the year 2011. To this aim, a descriptive statistics has been followed by a regression analysis (OLS), where the dependent variable measuring the urban attractiveness has been proxied by housing market prices. Besides, a Cluster Analysis (CA) has been developed in order to find differences and commonalities among the province capitals.

The OLS results indicate that living, people and economy are the key drivers for achieving a better urban attractiveness. Environment, instead, keeps on playing a minor role. Besides, the CA groups the province capitals according to the smart features, showing interesting results on the possible "smart specialization" of the cities.

The paper is structured into seven sections. The introduction is followed by the literature review on the concept of Smart Cities, and its measurement. Section three focuses on data and methodology. Descriptive statistics, econometric and cluster analyses follow. The last section is dedicated to discussion and policy recommendations.

KEYWORDS

Smart city, Italian province capitals, Housing market, Cluster analysis

1 INTRODUCTION

Since the most of the world population lives in urban contexts, it becomes crucial to identify the determinants of urban wealth and liveability. In particular, among the many definitions and characteristics of a "successful" city, the label of "smart city" has recently got the upper hand. The notion of "urban smartness" is thus attracting the attention of both policy-makers and academicians (i.e. European Commission 2012; Barca and McCann 2011). Among many different definitions, the "Vienna model" by Giffinger *et al.* (2007) appears as the most widely recognized. According to this functional model, the drivers of urban smartness can be grouped into six "smart" dimensions: economy, people, governance, mobility, environment, and living (Giffinger *et al.* 2007).

In this context, the present paper aims at investigating the role played by these "smart" characteristics in the capacity of the major Italian cities to attract people and economic activities. Therefore, the 103 Italian province capitals have been observed in the year 2011, by means of descriptive statistics and econometric analysis (OLS). The dependent variable is urban attractiveness that has been proxied by housing market prices (hereinafter HMPs), while the explanatory variables concern smart characteristics, and have been grouped according to the Vienna model, which is based on six "smart" dimensions (economy, people, governance, mobility, environment, living). Data on housing market prices come from the Scenari Immobiliari database, which records data at municipality level, in Italy, since the year 1993, while the smart characteristics have been gathered from primary and secondary data. Besides, differences and commonalities among the cities are explored by means of a cluster analysis (hereinafter CA).

The results of the econometric model (OLS) underlines that living, people and economy are the key drivers for achieving a better urban attractiveness while environmental issues stay on the backdrop. Besides, the CA showed that the most performing cluster (Cluster 1) is composed by larger "competitive" cities with excellent results in economy, governance, mobility, and living. The second best performing group (Cluster 3) is composed by large "attractive" cities mainly located in the North, which present the same characteristics of the first cluster, even to a lower level. Cluster 4, concerning the "liveable" cities, instead, includes medium-sized cities with all the variables above the average, except for unemployment. Finally, Cluster 2 collects towns located in the South and some others in the peripheral areas of the regions they belong to. These towns are small, and have on average the lowest scores in all the selected variable. However, several of them present results above the cluster average for at least one of the dimensions, suggesting a possible vocational "smart specialization".

The paper is structured into seven sections. After the introduction, the paper focuses on the literature review of the concept of Smart Cities, and the related variables and indicators adopted to measure "smartness". Data and methodology are then described in section three, while descriptive statistics is presented in the fourth one. Sections five and six are dedicated to the results of the OLS and cluster analysis, respectively. Conclusions follow in the section seven, which puts forward new research questions.

2 URBAN SMARTNESS: THE LITERATURE

In the current concept of urban competitiveness it results very important to appraise the successful cities' characteristics. A city can thus be defined in many different ways: intelligent, innovative, wired, digital, creative, cultural, and, of course, "smart". Specifically, after many contributes on the "intelligent city" in the 90s, mainly dealing with ICTs as key driver, the focus shifted to the "social" aspects of urban development: from the higher productivity of a more educated human capital (Shapiro 2006; Winters 2011), and skilled workforces (Berry and Glaeser 2005; Glaeser and Berry 2006), through the triple-featured (tolerance, talent, technology) "creative city" (Florida 2005), to the sustainable approach to growth, in both environmental and social fields (Hollands 2008; O'Grady and O'Hare 2012).

In the last few years, chiefly due to the global crisis, also the economic component of sustainability has been heavily involved, therefore, in a Smart City (hereinafter SC), economic growth, social and environmental sustainability are supposed to be with compatible one another. Even in the most recent definition of "senseable city", the MIT suggests a new path towards urban sustainability, which entails a deep use of new technologies for the everyday life of everyone (Ratti 2012), thus involving not only intelligence and innovation as tools, but also inclusion and liveability as goals (Mitchell 2007; Sassen 2011).

2.1 LOOKING FOR THE "SMART CITY" DEFINITION

If a strict definition of SC is not easy, some operational descriptions are anyhow available: a city is smart "when investments in human and social capital and traditional (transport), and modern (ICT) communication infrastructure fuel sustainable economic growth, and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu *et al.* 2011). Indeed, sustainability seems the only common feature to all the possible definitions of SC (ABB 2012), together with a large – maybe too large? – target of "quality of life" (Legambiente 2012).

As a conclusion, according to the most of the theoretical studies on SCs, whatever the disciplinary approach or the research background (institutional, academic or entrepreneurial), it is possible to state that a SC has two main goals: full general sustainability and quality of life, which may be summed up in the concept of "smartness". Furthermore, even if the most of the empirical analysis on SCs ends up choosing indicators for their many dimensions, in some cases useful research tool-frames have been also provided.

Actually, the most valued description of SC characteristics has been presented in a joint research by the Technology Universities of Wien and Delft with the Ljubljana University (from now on defined "The Vienna model"), which focuses on the strict relation among six axes of the urban area (economy and governance, mobility and environment, people and living) (Giffinger *et al.* 2007)[1]. In the Vienna model, a definition of SC is provided, according to which a Smart City is "well performing in a forward-looking way in six characteristics, built on the 'smart' combination of endowments and activities of self- decisive, independent and aware citizens" (*ibidem*, 11).

2.2 EMPIRICAL STUDIES ON SMART CITIES

Several empirical studies on SC have been conducted at both European and national scales. Apart from some case-study oriented works, the literature can be grouped into two categories: ranking analysis, which is definitively very popular and classifies cities according to selected indicators depending on a general or particular perspective of sustainability, and more complex analyses like hedonic prices method, correlation analysis, econometric models, and cluster analysis.

Focusing on the Italian cities, the most of the rankings consider only a particular group of cities, according to dimensional criteria: ABB-Ambrosetti (2012) for example, has ranked the 13 most populous Italian cities, while the Euromobility Report (2013) considers 50 municipalities where over 100.000 people live, in order to analyse and discuss the level of sustainable mobility. In some cases, they consider the whole sample of the

[1] Since this model has been adopted for the current research, it will be further investigated in the next methodology paragraph.

103[2] NUTS3 Provinces (Sole 24 Ore 2012) or capital provinces. Specifically, the ICity Rate report (Forum PA, 2012) analyses the "intelligent cities"[3], classifying them according to the Vienna model dimensions, using about one hundred indicators at the local and provincial scales. Similarly, according to "La Dolce Vita" (Colombo *et al.* 2012a; b), which ranks cities according to the quality of life level, the best performers show better results mainly in the economy and services dimensions, more than in those linked to environment or society, and climate.

On the contrary, the Ecosistema Urbano by Legambiente (2012) focuses on the environmental quality issue, considering 25 indexes (over about 70 indicators) that measure urban performance regarding air, water, energy and waste management, transports and mobility, green areas, environmental, and mobility policies. The best cities present good results in the most of the indicators like waste management (share of recycled wastes), ciclability, which considers the urban "bike-friendliness" level, and in the willingness to reply to the Ecosistema Urbano questionnaire.

Moving to the studies based on econometric or cluster analyses, Caragliu and Dal Bo (2012) focus on the impact of smart characteristics on urban performance – measured by per capita GDP – and investigate this impact at the local level for a sample of 94 cities in 14 EU countries in 1999-2006. They find that urban density is negatively associated to urban performance[4], while the smartness indicator – measured as the mean urban value for the number of visitors to museums per resident, the length of public transportation (in logs) and the number of administrative forms available for download from official web site (in logs) – is always positive and significant. Besides, cities specialized in industries with high-tech content[5] (knowledge intensive services – KIS[6]), with higher amenities, and more attractive as concerns tourist inflows are better performing.

Colombo *et al.* (2012a; b) analyse, on one side, the relationship between quality of life and housing prices, on the other side, the link between quality of life and wages within the Italian province capitals in 2001-2009. In this study quality of life is defined as the weighted average of a set of local amenities, branched into five main domains: climate, environment, services, society and economy (Table 4). It results that housing prices are higher in cities with less pollution, more green areas, and located on the coast. As concerns services, positive differentials are observed in cities with higher teacher-pupil ratio, better transport and cultural infrastructures. As concerns social conditions, housing prices are lower in cities with higher crime rates and higher shares of foreigners, while they are positively related to civic-ness and university enrolment. Finally, housing prices are higher in cities with higher value added per capita and lower unemployment rate. As far as the geographical composition is concerned, quality of life is highest in medium-sized towns in the Centre-North of Italy.

Finally, it is worth mentioning the recent analysis conducted by Siemens-Anci in 2012 on 54 out of the 110 Italian province capitals, identified according to the size: cities with more than 90.000 inhabitants. These province capitals have been grouped through a Cluster Analysis on the basis of five synthetic indexes[7] which represent: urban environment (air quality, urban green, water and waste managements), real estate stock,

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2 In the most of the studies, although using current information, due to the lack of data provoked by frequent administrative borders changes, the number of provinces is still 103, despite the fact that they are 107 since 2005 (adding four provinces in Sardinia) and 110 since 2009 (with Monza, Fermo and Barletta-Andria-Trani).

3 The "I" in the title of the report does not stand only for intelligent, but also for innovative, inclusive and interacting (Forum PA 2012).

4 This may suggest that cities in the sample are experiencing the right-hand side of the optimal city structure, where costs exceed benefits (Caragliu and Dal Bo 2012).

5 These cities are expected to outperform those with more traditional and lower value-added sectors.

6 See Organization for Economic Cooperation and Development (2005) for further details.

7 These indexes have been developed by means of principal components analysis.

energy management, mobility, and health service supply. Six clusters are identified. The "becoming cities" (cluster 5) have got below average scores in every measure, but the commonality among the 10 cities of this group[8] seems to be the growing specialization in one specific sector. The best cluster is the "Ideal Cities" one (cluster 3), which is composed by four medium sized cities in the North-East of the country, with the best scores in all the measures. It is followed by a small group of big cities (7) belonging to "good living and moving cities" cluster (4) where mobility and real estate stock are excellent if compared to the average values. If Cluster 4 presents low scores in the environmental measure, in the "ideal cities" Cluster 3, environment proves instead to be better taken into account. Two other groups (environmental and energy clusters), which account for 25% of the cities sample, seem concentrated only on the environmental issue, while the wealth cities, a geographically diffused group, show good results referring to the real estate stock and the health service supply as well.

3 DATA AND METHODOLOGY

The aim of the present paper is twofold. First, it aims at investigating the impact of smart characteristics on urban attractiveness of the 103 Italian province (NUTS3) capitals in 2011, which is proxied by housing market prices. Subsequently, differences and commonalities among the cities are explored by means of a cluster analysis. Data on housing market prices come from the Scenari Immobiliari database, which records data at municipality level, in Italy, since the year 1993, while smart characteristics, suggested by the Vienna model (Giffinger *et al.* 2007), come from various sources, and have been grouped into six axes.

The multiple definition of smartness is mainly based on the theories of regional competitiveness, thus considering the whole "infrastructural endowment" of the city, both the physical and the immaterial one. As a consequence, not only the "hard" factors, which account for efficiency like transport and ICT, and natural resources, are taken into account, but also the "soft" ones, like human and social capital, quality of life, citizens' and stakeholders' participation must be considered. Following this model, a city can be considered "smart" if its dimensions are "smart" in turn: smart economy mainly concerns competitiveness; smart people is about social and human capital; smart governance refers to participation; smart mobility affects ICTs and transport; smart environment involves natural resources; smart living is a synonymous of quality of life. According to the large multitude of rankings and empirical investigations presented in section 2, and adding some tweaks, many variables for each dimension have been chosen for the empirical analysis.

It is worth saying that some changes occurred in choosing the variables used by Giffinger *et al*. as to better differentiate the six dimensions, as to cope with data availability. In fact, since it has been very important to find as many data as possible on the city-sample, the local scale (province capital) has been strongly preferred to the larger ones. Furthermore, unlike the Vienna model, no regional or national level data have been considered. In some cases, data related to the whole province have been collected instead of those for the province capital itself: this was due to lack of data but also to be able to analyse a higher impact scale. Data were collected in desk research, by analysing primary and secondary data. Despite the huge data availability, a high correlation between couples of them suggested to reduce the number of selected variables to 14.

The urban attractiveness of the 103 NUTS3 province capitals is modelled by means of an OLS regression, where the dependent variable is PRICE (€/sqm) – market real estate price of the residential units in the semi-central area in 2011 (Scenari Immobiliari), and the explanatory variables are the following:

- TAX Income (€): average taxable income per taxpayer, for each Italian province capital in 2010 (http://www. comuni-italiani.it);

[8] These cities are mainly small-sized and in the South of the country.

- JKShare (%) : is the share of firms in the J and K sectors[9] over the total, by province in 2010 (CNEL), and represents the innovation level of the province the capital city belongs to;
- UNemplShare (%): is the share of unemployed people over the total in each province the capital city belongs to, in the year 2011 (Sole24Ore);
- ImmIntegrShare: is a Cnel index measuring the immigrants integration level[10] in the province the capital city belongs to, in the year 2009 (CNEL);
- Network: is the number of networks and associations the province capital belongs to on the total number of existing associations in the year 2012 (Ancitel);
- ResponseRate: is the administrative local institutions' replyness level, measured by the number of answers given to the Legambiente questionnaire in 2012 (Legambiente);
- UniResearch: is the number of universities and research centres in the city, year 2012 (Ancitel);
- Pollution: is the maximum number of times Particulate Matter (PM10) exceeded the limit level in the province capitals in the year 2009 (ISTAT);
- PopWasteShare (%): is the share of inhabitants making separate collection of rubbish over the total at province capital level in the year 2011 (ISTAT);
- BykeIndex: is a complex ciclability index within the province capitals in 2011 (Legambiente);
- Rain (mm): is the average of rainfall occurred in 2000-2009, at provincial level (ISTAT);
- ElderlyFacShare: share of facilities for elderly people over 1000 elderly in 2008 at provincial level (Ministry of Interior);
- InstitCult: number of institutions and cultural goods in the province capital level in the year 2012 (Ancitel);
- TouristShare: share of tourists staying overnight over the total inhabitants at the province level in 2010 (Sole24Ore).

Besides, region-capital dummy and macro-area dummy have been included in the model, in order to control for fixed effects. The equations suggest that urban attractiveness defined as real estate prices is explained by the explanatory variables as defined above.

Once urban attractiveness has been investigated, a k-means[11] cluster analysis is carried out in order to analyse similarities and differences of the province capitals in terms of smartness and urban attractiveness. In the Cluster Analysis, only 8 out of the 14 previous variables have been considered (Price, TaxIncome, JKShare, UnemplShare, ImmIntegrShare, Networks, Pollution, BykeIndex, TouristShare). Besides, the size variable (population) as classified by Legambiente (2012)[12] has been added to the analysis.

4 DESCRIPTIVE STATISTICS

As concerns the geographical distribution, the 103 NUTS3 province capitals are located in the northern areas (45.2%), South and Islands (34.3%) and Centre (20.4%) (Figure 1a). Focusing on the size of the province capitals, most of them are medium-sized, while a third of the sample is composed by small cities (Figure 1b).

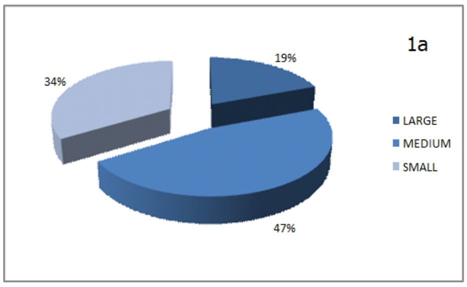
[9] According to NACE (Nomenclature statistique des activités économiques dans la communauté européenne) J and K are: Financial intermediation; real estate; renting, and business activities.

[10] In the index, Cnel considers the ability to gain access to local services (real estate market, education), and to be locally embedded (deviant behavior; naturalization – citizenship achievement – family reunification).

[11] In this k-means CA, each observation is placed in the group where it is closest to the means which represents the cluster itself.

[12] See footnote 4.

Besides, only about 20% are big cities (more than 200,000 inhabitants) with only four of them above 1,000,000 people.



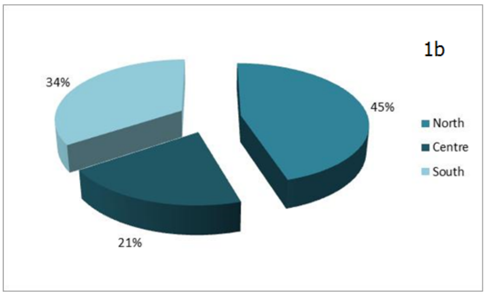


Figure 1 Italian province (NUTS3) capitals by Macroregion (1a) and size (1b)

Looking at the housing prices distribution among the capital cities (Figure 2), it results that about 10% show housing average prices ranging from 2,551€ and 4,550€ (cat.1 and 2), while the rest of the sample is almost equally subdivided into the left three categories. The housing prices of the first two categories (4,550-2,551) mainly refer to cities in the northern (7 out of 10) and central macro-areas (2 out of 10), while 88% of the southern cities belong to the lowest prices categories (4 and 5).

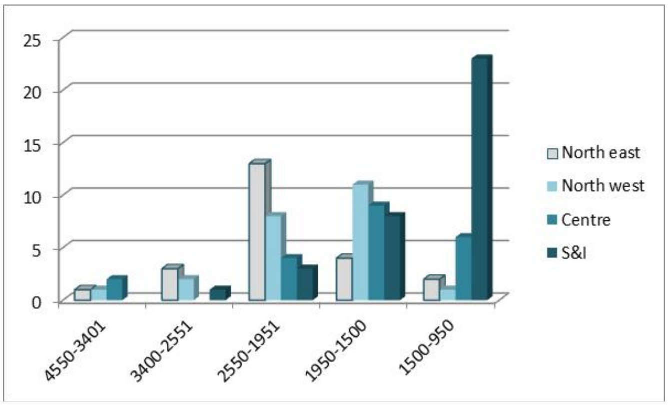


Figure 2 Price-class distribution by Macroarea

These first impressions are confirmed by the rankings of the first and the last ten cities in terms of housing prices, with Rome, Milan, Venice and Florence in the first positions with the highest housing prices (around 4.000€/sqm), followed by Bologna, Verona, Bolzano, Genoa, Naples and Turin, characterised by housing prices in the second category. Conversely, the last 10 positions of the ranking mainly concern southern cities, with the exception of Rovigo and Gorizia in the less developed areas of the North East.
As concerns the wealth of the cities, a good proxy of the GDP[13] is the average taxable income per taxpayer in 2010. Despite high housing market prices, Florence and Venice seem to be less "rich" than other cities: they are only 15th and 41st respectively. Southern cities, as expected, have a minor part in building the internal revenue: the first in this ranking is Caserta, in 19th place.
The housing prices are correlated with the other economy's variables, as expected. Indeed, cities with a more expensive housing stock are those with higher tax income, higher share of firms with high tech content (Knowledge Intensive Services), and with higher employment rate. Then, the most attractive cities are

13 GDP is not available at urban scale after 2004.

expected to host universities and research centres, have higher amenities, attract inflows of tourists. Besides, according to Colombo *et al.* (2012a), housing prices are supposed to be higher in cities with less pollution, more green areas, located on the coast.

5 OLS ESTIMATION RESULTS

The OLS model presented in Section 3 suggests that the real estate price of the residential units and the taxable income in the 103 province capitals in 2011 is related to a list of smartness' characteristics belonging to the six dimensions of the Vienna model. The results of the OLS regression are presented in Table 1 below, where four models have been run in order to control for the correlation between two variables (JKshare and UniResearchSh), and to control for fixed effects.

DIMENSION	VARIABLE	PRICE1	PRICE1	PRICE1	PRICE1
Economy	Tax Income	0.051921***	0.051358***	0.053748***	0.053188***
	JKshare	240.987***	237.2623***		
	UnemplShare	-31.5808***	-23.2098	-56.223***	-43.0048***
People	ImmIntegrShare	-16.9526***	-16.2596***	-16.5274***	-16.0254***
	UniResearch			24.17474***	23.89541***
Governance	Networks	37.23117***	42.66081***	16.72397	22.48166*
	ResponseRate	-2.90944	-3.40445*	-1.40335	-43.0048
Environment	Pollution	-0.68757	-0.87854	-0.10184	-0.35077
	PopWasteShare	-5.98467	-6.82482	-4.10813	-5.10405
	Rain	-0.32615	-0.35856	-0.0176	-0.09593
Mobility	BykeIndex	2.971613*	3.42406*	2.409295	2.732871
Living	ElderlyFacShare	0.550445	0.413728	0.22831	0.079027
	InstitCult	15.65109***	15.06742***	19.43383***	18.44719***
	TouristShare	16.76364***	17.45921***	13.6985***	14.1261***
	_cons	1377.517***	1404.84***	1853.976***	1916.689***
	DummyRegion Capital	Yes	Yes	Yes	Yes
	Dummy macroarea	No	Yes	No	Yes
	Obs.	97	97	97	97
	P-value	0.0000	0.0000	0.0000	0.0000
	R-2 – adj	0.7957	0.7942	0.7942	0.8000

Tab. 1 OLS results

The Economy indicators are positive and significant, suggesting, as expected, that province capitals with higher tax income and specialised in industries with high-tech content, are more willing to experience higher housing prices; conversely, cities with higher unemployment rates have a lower attractiveness. The cities specialised in high-tech industries are, therefore, expected to outperform those with more traditional, and lower value-added, sectors.

As concerns the "smart people" dimension, the availability of universities and research institutes is significant and positive suggesting that a city supplying this kind of services is better performing; conversely the index measuring the immigrants integration level at provincial level shows a negative and significant sign, thus stressing that the presence of immigrants, although well integrated, is still not positive for the housing market, by lowering average prices.

On the contrary, results are not so steady for the Governance and Mobility dimensions, since they gain and lose significance within the models, while the Environment dimension seems not to have any impact on the housing prices.

Interesting results are then provided by two out of the three variables related to the Living dimension: tourism and cultural heritage, which positively influence the housing prices. Both the variables can proxy the city's attractiveness, thus underlying that higher tourist inflows are positively associated with urban wealth and economic performance (Caragliu and Dal Bo 2011).

Finally, the geographical location of the province capitals plays a role: being located in the North of the countries increases the probability to have higher prices.

By contrast being the capital city of a region does not appear relevant.

6 CLUSTER ANALYSIS

The 103 province capitals have been clustered through a k-means CA, according to 11 selected variables. The following four clusters of homogeneous cities have, thus, resulted (Table 2).

DIMENSION	VARIABLE	CLUSTER1 Competitive cities	CLUSTER 2 Specializing cities	CLUSTER 3 Attractive cities	CLUSTER 4 Liveable cities	Average	Sign.
Economy	Price11	4163	1458	3008	2159	1895.59	.000
	clustDensity	2.50	2.69	1.83	2.54	-	.168
	JK_Sh	5.3	3.1	4.1	3.6	3.426	.000
People	ImmIntegr_Sh	45	54	49	55	52.599029	.041
	BykeIndex	53.6225	20.4891	41.0433	39.8560	29.920404	.000
Governance	Unempl_Sh	7	10	8	6	8.51	.000
	Pollution	38.9750	29.5071	34.5200	33.8969	31.957831	.022
Environment	Networks	17	5	11	8	7.01	.000
	Tourists_Sh	15	5	14	9	7.14	.017
	Centre	1	0	0	0	-	.303
Mobility	North West	0	0	0	0	-	.126
Living	North East	0	0	1	0	-	.007
	South	0	1	0	0	-	.000
	Small	0	1	0	0	-	-
	Medium	0	0	0	1	-	-
	Large	1	0	1	0	-	-
	Nr. of cities	4	58	6	35	-	-

Tab. 2 Cluster Analysis

The best performing cities (Roma, Milano, Venezia and Firenze) belong to the "Competitive Cities" Cluster (1) and are. very large, hosting high added-values activities (JK share), a good network of administrations and institutions (Networks), and various amenities attracting tourists (Tourist-share). On the contrary, despite a good sustainable mobility, pollution in these metropolis is very high. Housing market prices are also the highest.

The second best performing group is Cluster 3, composed by 6 large "Attractive Cities" (Bologna Verona Bolzano Genova Napoli Torino), mainly located in the North, which present the same characteristics of the first cluster, but to a lower level.

Cluster 4, composed by the "Liveable cities", instead, includes 35 medium-sized cities with all the variables above the average, except for unemployment. These appear as good cities to live in. The tail end is Cluster 2 "Specializing cities", with the most of the cities located in the South and some others in the peripheral areas of the regions they belong to. These are small cities, presenting on average the worst scores in all the selected variable, but many of them present results above the cluster average for at least one of the dimension, suggesting a possible future smart specialization, which could help in improving the current situation.

Furthermore, considering both the results of OLS and CA, it results that Economy proves to have a strong impact on housing prices (both unemployment and skilled employees are significant for the CA), together with People dimension.

Governance and Mobility, whose impact was undefined according to the OLS, show high scores in the cities with highest prices. In the CA the people dimension is represented by the level of immigrates' social integration, which seems to lower housing market prices. Besides, pollution is higher in the richest cities.

7 CONCLUSION

The OLS analysis underlines the key role played by the Economy, People and Living dimensions. Indeed, it results that most attracting cities are "richer", show high employment rates, are specialised in high technology sectors, host universities and research institutes, belong to a high number of networks, and are more attractive for tourists. These cities are, then, more likely to be located in the north of the country.

On the other hand, better climate, lower pollution levels (Environment dimension), and better mobility (Mobility dimension) do not seem to impact housing prices significantly. Similarly, the groups of the competitive and attractive cities, as defined by the CA, present good results in the economy, living, mobility and governance dimensions. Besides, they are located in the north- centre-of the Country.

In both the analyses, on the contrary, Environment does not seem to play a key role, as already highlighted by the empirical contributes quoted in Section 2.2 (Caragliu and Dal Bo 2012; Colombo *et al.* 2012a; b; Siemens and ANCI 2012). Mobility, as well as density, is worth to be better and deeper analysed because its result is not univocal.

Focusing on the "specializing cities" of Cluster 2, it is worthwhile to select "in each region a limited number of sectors in which innovation can most readily occur and a knowledge base built up. [This] approach [is] defined in the current policy debate as 'smart specialization'" (Barca 2009, XVII).

Smart cities could have the best scores in many dimensions, but, since there is not "one-size-fits-all" strategy, for some cities the smart specialization could be the "therapy". Besides, this also implies that the success of an area or region is largely affected by the set of local institutions that are, in turn, path-dependent and rely upon the local characteristics.

Actually, if place-based policies matters on the way to smartness, they should be implemented, within a set of general priorities, by local actors with specific knowledge of the spatial dimension and characteristics of the area. It is, therefore, important to take into account both material and immaterial factors in framing specific place-based policies, at the top-down and bottom up levels, aimed at achieving better urban performance and attractiveness through smart components.

Furthermore, fixed/geographical effects in the OLS and CA also suggest that differentiated policies are expected to be successful, thus depending on the regions will adopted them.

Last but not least, smart cities – with their high level of data availability – will be faster and more effective in implementing strategies and policies.

Finally, further research needs to focus on the potential omitted variables issue, thus trying to better investigate the variables and dimensions that did not play a significant role in the present analysis.

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BEYOND DEFINING THE SMART CITY

MEETING TOP-DOWN AND BOTTOM-UP APPROACHES IN THE MIDDLE

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ABSTRACT

This paper aims to better frame the discussion and the various, divergent operationalisations and interpretations of the Smart City concept. We start by explicating top-down approaches to the Smart City, followed by what purely bottom-up initiatives can look like. We provide a clear overview of stakeholders' different viewpoints on the city of tomorrow. Particularly the consequences and potential impacts of these differing interpretations and approaches should be of specific interest to researchers, policy makers, city administrations, private actors and anyone involved and concerned with life in cities. Therefore the goal of this article is not so much answering the question of what the Smart City is, but rather what the concept can mean for different stakeholders as well as the consequences of their interpretation. We do this by assembling an eclectic overview, bringing together definitions, examples and operationalisations from academia, policy and industry as well as identifying major trends and approaches to realizing the Smart City. We add to the debate by proposing a different approach that starts from the collective, collaboration and context when researching Smart City initiatives.

KEYWORDS

Smart City, Local Innovation, Platforms, Urban Development, Mobility

1 INTRODUCTION

The city is more than ever the axis of humanity. Not only are urban centres the heart of the global economy, generating 70% of global GDP (see e.g. De la Peña, 2013), they are also home to more than 50% of the world's people with a steadily rising tendency; in 2050, according to the United Nations, it is expected that cities will host more than 70% of the world's population. Without any doubt, urbanization is and will be the defining trend of the 21st century (see UN Department of Economic and Social Affairs, 2008). This relatively new imbalance between rural and urban population poses many and diverse challenges for cities, their governments and citizens.

A prerequisite to accommodate this scale of urbanization are without any doubt well-functioning infrastructures for urban areas, ensuring efficient and effective urban processes. As a consequence, investments into urban infrastructure are likely to continue and grow (United Nations Human Settlements Programme, 2012). An accepted idea in this regard is to incorporate modern technology into urban structures. As more citizens (or consumers, depending on the point of view) move to urban areas, actors from the ICT industry naturally become increasingly interested in offering services that are tailored to life in the urban environment. Cities and local governments are at the same time exploring the role that new ICT services and products can play in increasing the quality of life of their citizens or optimizing internal processes. In recent years, this quest is most often captured in the "Smart City" concept (Townsend, 2013). It originates at the crossroad of technological progress and the realization that urbanization up until today cannot accommodate the expected demographic and environmental circumstances of the future. The Smart City concept has become key in bridging academic research, projects and commercial initiatives exploring the role of technology in urban life.

However, given the proliferation of the term, a lot of different operationalisations, approaches and definitions of the Smart City exist today and a lack of overview in thinking about the concept persists. The interest of the public, academics and media has increased in recent years, pushing forward an often almost science-fiction like discourse situated between concerns about control, freedom and privacy, and enthusiastic accounts about increased efficiency, sustainability, and generally a better world and higher quality of life for everyone. However, establishing an all-encompassing, definite definition is as difficult as projects, opinions and initiatives in the field are diverse.

Perhaps the goal then should not be chasing this all-encompassing definition, but rather having a clear overview of what stakeholders are talking about and the different viewpoints on the city of tomorrow (and in some cases today). After all, who would want to live in the rhetorical alternative to the Smart City: a dumb city? Therefore the goal of this paper is not so much answering the question of what the Smart City *is*, but rather what the concept can mean for different stakeholders as well as the consequences of their interpretation. We do this by assembling an eclectic overview, bringing together definitions, examples and operationalisations from academia, policy and industry as well as identifying major trends and approaches to realizing the Smart City.

First, we explore the Smart City as a top-down concept that is dictated by business potential, commercial logic and efficiency thinking, followed by the opposing viewpoint on the Smart City as one that should be predominantly orchestrated from below, by empowered and active citizens. For each of these approaches we provide examples as well as pros and cons and we end on a new view of these opposing approaches in an effort to "meet in the middle" and push the Smart City thinking forward.

2 TOP-DOWN

"A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens" (Hall, 2000). The first approach we assess here adheres to top-down dynamics, often closely related to the technologically deterministic idea of a "control room" for the city. It aims at providing an ICT-based architecture to overview urban activities as well as the tools to (automatically) interact with infrastructures and adjust parameters to predefined optima (IBM, 2009). Hall's definition of a Smart City above illustrates the strong emphasis on optimization through technology. Accordingly, IBM defined the three steps for making cities smarter as instrumentation, interconnection and intelligence.

Apart from gathering the data, a large part of the processes that essentially constitute this approach consists of the calculations, visualizations and predictions based on the gathered metrics: *"[T]he development of smart cities involves the application of [ICT], environmental sensors, digital footprints of the inhabitants, manipulation of the resulting data using statistical techniques, and finally the use of complexity modelling and advanced visualisation in order to make sense of it all."* (Campkin & Ross, 2013, p. 3).

Providing the systems that are capable of working with these vast data sets, referred to under the moniker of "big data", then becomes an interesting business. This way of making cities smarter therefore promises enormous opportunities for large private companies, such as technology vendors, network companies and software industry players. They are able to provide the corresponding tools to this sort of Smart City and can expect potentially enormous revenue from rolling out their proprietary solutions in large and small urban areas. Several cities have already been convinced of these propositions, with Rio De Janeiro serving as an often cited example (Singer, 2012).

In its most extreme manifestation, a top-down approach translates to cities that are planned, designed and built from scratch with the optimization of urban processes through technology in mind. The examples of Songdo and Masdar can be seen as the pinnacle of this particular vision of the Smart City. But both have been heavily criticized for being sterile, overly planned, prohibitively expensive, anonymous, uniform and conformist (Conway, 2013; The Economist, 2013; Sennet, 2013) and the result is that these cities struggle to be completed within the predicted budgets and timeframes and/or do not attract enough economic activity (and thus jobs) so that people want to move there.

Of course in most cases, technology will need to be integrated into existing urban infrastructure. There are large potential benefits tied to having an integrated Smart City solution in a city: many different services and infrastructure systems can be managed from one central hub, keeping oversight on many divergent aspects of life in the city. The focus on integrated infrastructure and technology is reflected in the following description of what the Smart City is: [A city] "*connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city"* (Harrison et al., 2010). The Brazilian city of Rio de Janeiro was amongst the first to implement the integrated Smart City solution developed by IBM; the 'Intelligent Operations Centre'. This solution combines feeds from over 560 cameras and can display over 60 layers of data, gathered from sensors across the city on a map. Installed after a natural disaster that killed almost 70 people, the initial goal of the system was to increase emergency response time, but has evolved into a wider Smart City solution. The mayor of Rio, Eduardo Paes, is one of the biggest proponents of the integrated solution: "I sleep better thanks to it. The worst thing is not having the information, to not have the tools to act. But we do now." (Soffel, 2013)

The huge economic potential is - at least to the same degree as its potential for improving the urban - the main driving force behind this approach and the main reason for its formation. Many major IT companies and municipalities around the world are looking for their slice of the Smart City pie. Market researchers and consultants of PikeResearch have predicted that global investment in Smart City technology infrastructure will reach $108 billion by 2020 (see Pike Research, 2011).

IBM and Cisco, among others - respectively with their 'Smarter Planet' and their 'Smart+Connected Communities' initiatives - have already established themselves as distinguished players in the field. They are among those large technology vendors, which have realised the potential of the Smart City and are actively seeking out and soliciting local governments to invest in their respective technologies, already rolling out various initiatives. While these companies are competing, they also appear to be specializing in specific aspects of the Smart City, aptly put by Townsend (2013: p.63): "If Siemens and Cisco aim to be the electrician and plumber for the Smart City, IBM's ambition is to be their choreographer, superintendent and oracle rolled into one".

2.1 DISCUSSION

Certain kinds of top-down visions have been heavily criticized with the main argument that they are dictated by commercial interests, and that they entail questions of control and privacy. The "control room" Smart City approach, which aims at monitoring all aspects of urban life might soon result in an ubiquity of data collection, presenting a "set of potentials disturbingly consonant with the exercise of authoritarianism" (Greenfield, 2012, para. 31). Too much monitoring and too many integrated technologies and infrastructures can pose actual threats for freedom and privacy, whether controlled by private actors or ruling bodies.

However, the shortcomings of a top-down Smart City might go further. What has also been referred to as a "city-building industry" (Joroff, 2008) or as the outcomes to "assembly-line cities" (Koolhaas, 2011) might not only hamper the innovation potential inherent to cities, but in some cases even have detrimental effects:

"More damningly still, the big technology companies are selling 'smart city in a box' solutions to cities, walled gardens that prevent scalable local business innovation." (Hemment & Townsend, 2013, p. 8)

The approach to the Smart City these companies take essentially revolves around efficiency: algorithms, measurements, optimization and so on. This gives rise to the question of what is being measured - and more importantly, what is not – as well as who has access to the measurements, who is being excluded and at what cost? In Rio for example, open hospital beds and enrolments in schools are not monitored by the integrated Smart City system (De La Pena, 2013). As the deputy mayor of Barcelona, Antoni Vives, stated aptly: *"There is nothing more dangerous [for a Smart City] than a stupid mayor and an eager company putting strange stupidities into the heart of the city*" (Smedley, 2013). After all, the Smart City is - alongside its value for commercial operations - to a high degree marked by the marketing and promoting of cities, competitiveness, and by interurban competition. What often results is commodification of public space and governance where non-democratic actors are able to exert too much leverage within complex decision-making structures.

The approach to the Smart City, as assessed above, then becomes an ambiguous one. On the one hand, top technology vendors have resources and knowledge at their disposal, on which the public sector needs to rely while facing urban challenges. Furthermore, the business potential in this context is too high for companies with ambitious commercial targets to resist. On the other hand, cities are about citizens, about the people who live and use them; in terms of for whom they are built, but also in regards of the potential for innovation and finding appropriate solutions. Therefore, this top-down vision is contrasted by the opposite: a purely bottom-up view on the Smart City, which is outlined in what follows.

3 BOTTOM-UP

These architectural, topical, infrastructural or top-down viewpoints are juxtaposed against a more experimental, bottom-up understanding of what a Smart City could be. In this perspective, change and improvement comes only from the people "using" the city. It dismisses any form of top-down urbanization, in particular with the involvement of powerful private companies. The bottom-up Smart City is, foremost, about the *Smart Citizen;* those who live, work, and engage in all kind of activities in the city. Rather than working towards centralization, such a view on the Smart City takes a decidedly distributed approach, supporting and accepting some form of chaos. Greg Lindsay formulates this as follows: *"The bias lurking behind every large-scale smart city is a belief that bottom-up complexity can be bottled and put to use for top-down ends — that a central agency, with the right computer program, could one day manage and even dictate the complex needs of an actual city. The smartest cities are the ones that embrace openness, randomness and serendipity — everything that makes a city great"* (Lindsay, 2011).

Embracing this "chaos" has also been referred to as "the default mode of urban development" (Echanove & Srivastava in De la Peña, 2013). It can be experienced in parts of cities, which central planning and control did not steer, often because of their nature as illegal settlements and slums. These settlements seem chaotic, growing 'by the default mode', brimming with networks of social and business relations, which are, however, most often not accounted for by decision-makers. Dharavi for example, the biggest informal settlement in Mumbai, is said to constitute up to 25% of the city's economy. Still, there are neither maps of its streets nor accounts of its economic activities.

Although these characteristics have positive impact on the local scale, they often conflict objectives of decision-makers, urban-planners, and dynamics of the globalized economy. Chaotic bottom-up processes oppose the idea of a master plan, an 'ideal' state of place. Therefore, the top-down approach to Smart City (in fact, to urbanism in general) often intends to control, rather than find ways to enable and employ this default mode. Since the city is a system of systems put together by people who bring it to life, it is complex and cannot be but dynamic and flexible. Consequently, the solution to urban challenges of the future, a real Smart City, is more than just technological, networked and intelligent: it is about people. The Smart City presents an unparalleled opportunity to enable citizens, connect them and make them 'smarter'. It has the potential to empower them to participate, encourage them to shape urbanization and make it more sustainable together. De la Peña (2013) compares this complexity of the city with the "non-hierarchical complexity" of the internet: as the Internet is open and participatory, an smart city should actively and consciously enable and encourage citizens to shape their own urban experience.

Examples of these purely bottom-up approaches can be found in citizen initiatives and even (semi)-illegal interventions in the public space, such as so-called guerrilla bike lanes where citizens, unhappy with local biking infrastructure, paint bike lanes on the street without authorization (Muños, 2013). These types of initiatives are also referred to as tactical urbanism (Hamdi, 2004). Tactical urbanism tends to consist of "small scale interventions [that] are characterized by their community-focus and realistic goals" (Berg, 2012) and are often short-term or temporary, cheap and aimed at increasing quality of life in a certain way or addressing a specific neighbourhood concern. However, the instigators of these small projects often hope to achieve more and they actually do effect change: *"The goal is not to simply do a cool project that will get cleaned up by the city or thrown away, but to make something – even something temporary – that will change how a place works and is perceived. And once that change has been made, to figure out how it can be made again or made permanent"* (Berg, 2012). In such a perspective, what defines the Smart City is not the infrastructures or architecture it offers, but the ways in which its citizens interact with these systems as well as each other.

3.1 DISCUSSION

Whereas the idea of a master plan, an ideal, measurable and controllable state often delivers deficient outcomes, relying solely on bottom-up processes also appears unlikely or even infeasible. Citizens are not detached from the wider urban context they live in, with other stakeholders playing - in some cases powerful - roles. Although the examples listed above can be appealing or charming and have in some cases impact and effect some change, they lack a vision on the issue at hand, are often (very) short term, can conflict with some long term goals set out by local policy and in some cases even be illegal. We like to argue for a "Smart Citizen" that uses a variety of tools to interact with and move around the city, and for whom the emphasis lies on his/her citizenship, rather than technology as a primary factor. However, relying purely on bottom-up initiatives remains problematic with regards to scalability, interoperability, barriers and incentives to entry. Thinking about the city of the future then cannot only place any and all responsibility for its success with its citizens.

4 THE SMART CITY AS A LOCAL INNOVATION PLATFORM

While both views and approaches to the Smart City have their merits, we have also illustrated that they each exhibit substantial problems: "Change seldom arises from purely top-down or bottom-up systems and processes." (Shepard & Simeti, 2013) Therefore, we propose a more nuanced interpretation, one that combines top-down and bottom-up approaches, and establishes the Smart City as a *platform* that fosters collective (local) intelligence of all affected stakeholders. After all, cities essentially constitute shared responsibility and resources (Campkin & Ross, 2013), and can be seen as a system of systems (Fistola & La Rocca, 2013). This means looking at the Smart City as a meeting place where the public sector, private interest and citizens can come together to generate new value, to collaborate and innovate together. Smart Cities can only be successful if they act as local innovation platforms that bring together all involved stakeholders. Still, "no one has so far found a way to intelligently bring together the big technology platforms offered by global corporations, with local technology projects and the interests of citizens" (Shepard & Simeti, 2013, p. 10). O'Reilly (2011) embraces such approaches and conceptualizes them, describing how technology can play a role in bridging interests of the public sector, private interests and citizens; he introduces the ideas of *government as a platform* and "government 2.0". The latter refers to "the use of technology - especially the collaborative technologies at the heart of Web 2.0 - to better solve collective problems at a city, state, national, and international level." Regarding the city as platform in this light means that it acts, like the Web, primarily as an intelligent broker, connecting the edges to each other and harnessing the power of the users themselves (see O'Reilly, 2005). The platform is the intermediary, the enabler of interaction of multiple actors who have corresponding interests or needs. The delivery of public services in such a reciprocal relationship between all stakeholders, for instance, is very appealing and promising for developing truly Smart Cities.

4.1 THE ENABLING CITY

As mentioned before, technology is not necessarily the most critical factor for smartening a city. Smartness still fundamentally depends upon people. In fact, one can argue that, due to individual and collective intelligence, "cities have always been 'smart'" (Campkin & Ross, 2013, p. 15). In this light, the concept of read/write urbanism adds an interesting idea to the discourse. It describes the interplay of people with their urban environment under the influence of networked information. The 'reading' part is obviously about the access to data/information enabled by a smart environment. 'Write' urbanism adds the possibility of exceeding the passive experience of space by being "empowered to inscribe [...] subjectivities in the city itself." (Greenfield & Shepard, 2007, p. 13) In other words, it is the possibility for every user to participate in shaping and improving his/her environment.

Interpreting the smart city as platform is about seeing (and fostering) it as a framework, which enables the 'writing' in addition to the 'reading'. It is also about establishing that collaborative processes, the potential of "everyday experiences" and local intelligence are integral: this enabling city combines the creativity of citizens and experts, politicians and businesses for making cities in collaboration. Even though technology and connectivity is not necessarily the most critical factor in achieving this aim, it has the potential to be the enabler (Hollands, 2008, p. 310). *"In the age of connectivity, it is no surprise that collaboration is increasingly seen as a design principle, a style of thinking and acting that elevates the practice of problem-solving from a managerial tool to a way of thinking about participation itself."* (Camponeschi, 2011, p. 16).

4.2 OPEN DATA

Examples of the city taking up a platform role can be found in the growing trend of open data initiatives and "hackathons", enabling and stimulating developers to create applications based on cities' databases. City governments are "sitting" on a wealth of information related to divergent aspects of life in the city, but this data is either not publicly available or not easily interpretable. This has sparked a movement to encourage the opening of datasets, under the "open data" moniker, which is gaining traction across local and national governments throughout the world. The Open Knowledge Foundation is one of the strong proponents of opening up data in the name of government transparency, increased efficiency and better services for the public as a result. OKFN defines open data simply as "…data that can be freely used, reused and redistributed by anyone – subject only, at most, to the requirement to attribute and share-alike" (OKNF, 2012).

Cities attempting to leverage their datasets as assets can employ different strategies, of which the most popular seems to be the organization of an "Apps for X" event in which developers get access to the data and can win prize money for the best applications or ideas. As these events are increasingly organized around the world, more questions are raised about the sustainability of the apps and ideas that come out of them. While the organization of such events can be a relatively cheap way of promoting the datasets cities opened up and can lead to creative and innovative ideas (also in the context of the operationalisations of the Smart City we saw earlier), actually valorising the results of hackathons or transforming them into sustainable businesses or spin-offs has proven far more difficult and will remain a challenge for cities in the short term.

However, gradually, the results of various open data projects are becoming measurable a few years after the consolidation of the concept and opening up the first data sets. A notable example is Transport for London, the city's public transport agency, which after some initial resistance is now fully supporting an open data strategy. Since the project started, around 500 different mobile, web and other apps have been created that make use of the real-time data provided by the company. Around 5000 people are indirectly employed as a result of opening up and so the return for the city and citizens is high (Stott, 2014). The transport agency evaluated the open data project in the same way it does with all its transport projects, using the same economic and social indicators (including for example time won by commuters because of increased information provision). Where typical projects expect a return on invest of 1.4:1 (for each pound invested, at least £1.4 should come out), the open data project saw a return on investment of no less than 58:1, leading researchers to double check the evaluation process (Stott, 2014). Perhaps most telling of all, since the launch of the open data portal and the resulting success, Transport for London does not make its own public transport applications anymore. This example shows one way in which the city or local government organizations and administrations can play a platform role, providing the framework wherein new ideas, value and services are created.

4.3 OPEN INNOVATION, CO-DESIGN & LIVING LABS

For our platform approach to the Smart City, the concept of open innovation can be highly relevant. It is about 'public-private-people partnerships', i.e. organized collaboration between all involved stakeholders (governments, businesses, users/citizens etc.). It includes co-creation of services, products and much more, and the availability of open platforms that facilitate the necessary collaborative processes and interaction (DG Communications Networks, Content and Technology, 2013, p. 56). Co-design and co-production approaches emphasize engagement by those responsible for delivery of a service or product with stakeholders in general, and with the end user/customer/citizen in particular (Smart Cities Project, 2011, p. 6). The aim is to establish processes that allow all players to make constructive contributions according to their own role and knowledge without a stakeholder or a need being more important than another. Co-design can be defined as "activity where the users of the planned new system actively collaborate in (a) defining what the system should do (problem definition), (b) the development process and (c) acceptance of the results." (ibid, 2011, p. 6) Co-production then describes the continuing active involvement of citizens as users beyond the completion of the design-stage (ibid, 2011, p. 7). Contrary to implementing the Smart City in a top-down fashion, this approach is based on the theory that relationships between the technical, the social, and the subjective are interdependent; social shaping of technology, controverting technological determinism by arguing that technology is not a given, but what it is chosen to be (see Bakardjieva, 2005). Open innovation is already being practiced, in the form of Living Lab projects that muster the stakeholders required to make an innovative initiative become a success (Schuurman et al., 2012). Living Labs provide the platforms for open innovation, which facilitate productive collaboration and thereby ensure that development complies with real problems and needs.

4.4 DISCUSSION

We have illustrated that a purely bottom-up or top-down view on the Smart City will struggle to be effective and future-proof, and therefore suggest looking at the city as a platform. But also local innovation platforms are not without their potential difficulties. First of all, organizing such an intense collaboration as required by this approach is not easy. And when it is set up, the collaboration could still run into issues of various natures: diverging visions, operational issues, financial inhibitors and so on. It is therefore important to consider who should or could organize and facilitate the collaboration and under which conditions partnerships come to be. Integrating enough resilience into partnerships, so that when one partner is forced to end the collaboration the project may still continue in an adapted form, can also be decisive in this regard. Alongside organizational difficulties, valorisation can be an issue of local innovation platforms as well. This relates back to the scalability question, commonly of particular denotation in a EU context, and should need to increasingly be a point of concern for open innovation and related initiatives. How one transcends the project context and can move a concept or idea into a real application or service that adds value to citizens is one of the major challenges.

A final point of attention for any and all Smart City projects should be the digital divide. Around the world, digital services in many different forms are becoming consolidated as an integral part of daily life. As these services become more integrated into our daily (urban) context, we need to be aware of people that are excluded from these services, or do not have the access or skills to use them in a proper way. Education, in combination with the offering of alternative ways of getting access to public service, needs to be top of mind with involved local policy makers in ensuring that no one is excluded from access and the required skill set to participate. Only then, any approach can honestly be called smart.

5 CONCLUSION AND OUTLOOK

In spite of the many attempts at definitions, the Smart City concept remains elusive. However, it is an indication of the increasing need to develop new ways of looking at the city of the future and to think about structured approaches to provide answers for the diverse and complex questions companies, citizens and governments face there. Rather than attempting a holistic and general definition of what a Smart City is we prefer to clarify our perspective on the concept after having assembled this overview. It should be clear we consider cases that are linked to the urban space and the interactions between the physical and the virtual, which are mediated by ICTs (be they social media, innovative wireless networks, mobile devices, cloud technology etc.) or developed using innovative methods (such as co-creation, living labs research, PPPP business models etc.), and that involve or engage citizens in innovative experiences with the goal of increasing their quality of life in meaningful ways. Smart Cities then, should capture and foster creative and collaborative innovation through (direct) interactions between public bodies, private actors and citizens in:

- Dealing with the next **data** flood (emerging from linked open data, big data, the internet of things, sensor data etc.);
- Identifying and tackling new **relational complexities** between actors;
- Facing **grand societal challenges** in a local context (e.g. green mobility, security, new forms of local and participatory governance etc.);
- While offering innovative and **engaging experiences** to citizens.

These are the emphases we would like to make in the on-going discussion and operationalization of the Smart City concept. We argue that collaboration between the public sector, private actors and citizens, and all those players amongst themselves, is the key for making cities smarter. It is working together, especially in dealing with the vast amounts of information and data that will increasingly arise of modern cities, allowing us to tackle some of the major urban challenges ahead of us, and here today.

At the basis of the Smart City, we see the interaction of the three concepts below as being the constituting elements of a future looking, "Smart" City that is serious about innovation. Such a place should be collaborative, collective and contextual.

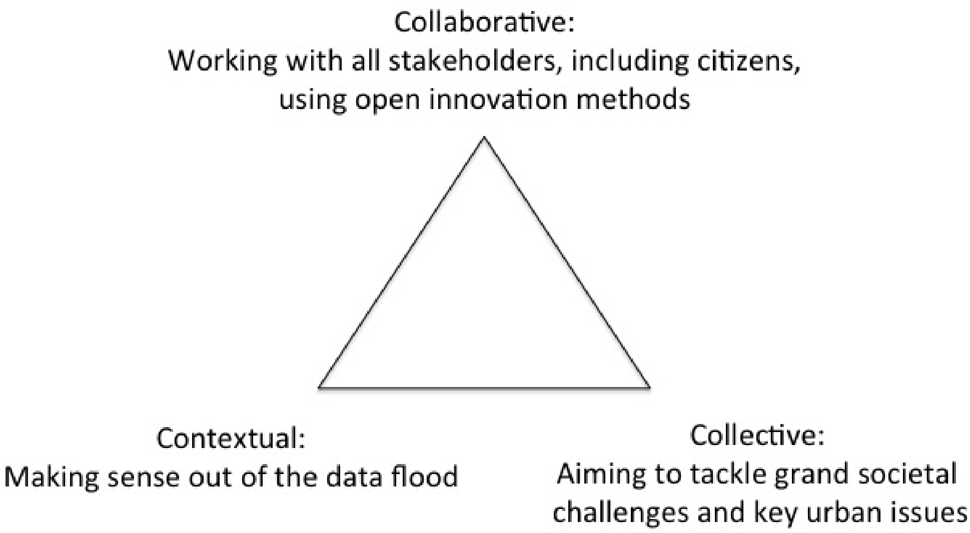

Fig. 1 Three elements constituting a Smart City

As we have illustrated and argued above, a purely top-down view on the Smart City carries a danger of authoritarianism with it, while a bottom-up-only approach leans towards chaos and lack of long-term vision. We argue that rather than trying to find the perfect definition for what the Smart City is or should be, closely looking at who is making claims about the Smart City, with which motivations and consequences, is at least equally important. Approaching the concept using the three elements presented above is one way of trying to keep this holistic perspective.

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RESILIENCE THROUGH ECOLOGICAL NETWORK

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ABSTRACT

The paper explores the strategic role that urban biodiversity and ecosystem services management, natural infrastructure and adaptive governance approaches can play in making our economies and societies more resilient and in linking human societies and the natural environment. Resilience – a concept that entered the debate on urban governance – means the ability of urban systems, considered as linear-systems, to react to external disturbances by returning to some socio-ecological equilibrium steady-state by overcoming a crisis period (Gunderson & al. 2010, Newman & al. 2009). In this view, green infrastructures can assume a strategic role in restoring and enhancing the ecological and environmental livability in urban areas. Starting from the International and European context, the paper discusses innovative programs and interdisciplinary projects and practices (some cases in Turin Metropolitan Area) to demonstrate how green infrastructures can increase the adaptive capacity of urban systems in term of resilience. They can contribute to increase the ability of European cities to adapt to climate change and to reduce their ecological footprints, to enhance security and life quality.

KEYWORDS
Green infrastructures, Landscape and ecological services, Agro-ecosystems, Resilience

1 THE RESILIENCE PERSPECTIVE

The world is increasingly urban and by 2050, almost three billion more people will live in cities. In Europe around 75% of the population lives in urban areas and in some countries this figure is estimated to grow to 80% by 2020 (UN 2012). Urbanization interacts with global environmental change in important ways: although urban areas account for only 2% of Earth's land surface, they produce 78% of greenhouse gases, thus contributing to global climate change; cities also play a central role in alteration of global biogeochemical cycles, changes in biodiversity due to habitat fragmentation and exotic species, and changes in land use and cover far beyond the city's boundaries (i.e., within the urban "footprint").

In this context the importance of urban biodiversity and ecosystem services management, natural infrastructure and adaptive governance approaches can play a strategic role in making our economies and societies more resilient and in linking human societies and the natural environment.

In this view, the paper will define: a) resilience; b) describe the key role of resilience in urban socio-ecological environment; c) describe the ecological infrastructure for developing resilience in cities; d) describe a study case in Italian metropolitan areas related to the agro-ecosystem enhancement for river resilient management.

1.1 THE RESILIENCE AND ECOSYSTEM SERVICES

The concept of resilience bringing into play the sustainability of the territory (Kates et al., 2001) as an innovation of social-ecological systems (Gallopín *et al.* 1989; Berkes and Folke 1998), based on the reciprocal interaction and adaptation between man and the environment / coupled human–environment systems (Turner *et al.* 2003). Adaptability refers to the capacity to adapt to future changes in the environment of the system concerned, taking on a multitude of meanings, which permeate anthropology, human geography, social science (Folke 2006), risk management (Kasperson *et al.* 1995), the fight against climate change and the planning of the territory (Davoudi 2012). In the cultural debate there emerges a utopic vision that imagines a future for the city, the territory and the landscape which, in its natural and anthropic characteristics, launches a non-linear transformation process which invests the quality of the performance of the environmental and territorial system. This perspective gives a central role to the ecosystem services for adaptive management of the environmental resources. The adaptive management affects the urban and regional planning contribution for resilient development of a socio-ecological system; in the urban system there is continuous interrelation among ecological functionality and human creative use and transformations. As Porter and Davoudi (2012) the resilience looks at city as a linear system, the theory of complexity demonstrates that cities are non-linear systems. They are open adaptive complex systems that are based on their capacity to adapt to the continuous changes linking the natural and cultural system (the community and institutional capacity and creativity) in order to react and develop its system (Portugali 2000; Brunetta and Moroni 2012).

Many cities are developing a new perspective development in relation to adaptation plans for resilience (such as Ancona, Barcellona, Copenhagen, etc.). The adaptation plans assume a system perspective for urban development, based on integration of environmental functionality and socio-economic organization, development of management tools, and actions for developing local reactivity based on institutional capacity and on the urban planning and regulation flexibility (such as the local initiatives ICLEI; the networking and exchange perspectives in Global Forum on Urban Resilience and Adaptation, Bonn, May 2012). This perspective can be analyzed using the Panarchy Model that is not a deterministic cycle and that define the 'evolutionary' approach of resilience (Davoudi 2012; Brunetta and Baglione 2013). Firstly, cities are open

because they exchange matter, energy, informations and people with their environments. Being open implies that the system continuously reacts to external changes, in an adaptive manner. Secondly, cities are complex because 'their parts are so numerous, and changing, that there is no way to describe them in terms of cause an effect (as did the urbanists of the 1950s and 1960s), nor in terms of probabilities (as did the urbanists since the end 1960s and the regional scientists of the 1970s and 1980s)' (Portugali 2000, 46).
This perspectives implies a continuous need to consider the interaction among the following key factors:

- a community based approach for planning and risk assessments based on a wide local collaboration for adaptation between stakeholders, within communities, forming partnerships with business (only 11% of cities worldwide; Global Forum 2012). It will also involve local government units at international level to effectively steer cities along a resilient path (Joann, Nadkarni and Rhie 2012).
- a systems perspective integrating solutions into all aspects of city management (logistic, urban agriculture, green infrastructure, renewable energies, social and political aspects, private involvement, land-use plans and building regulations, etc.)
- a strategic perspectives in spatial planning, for developing adaptive capacity: a long term plan to mitigate risks and to evolve living conditions in urban systems (such as Copenhagen Climate Change Plan -2011- that reads adaptability as 'a competitive advantage - cities capable of protecting business and citizens from climate related threats' creating conditions for more attractive places where to live, work, and invest).

We assume that resilience is the ability of urban systems, to react to external disturbances by reaching a socio-ecological equilibrium steady-state (Gunderson *et al.* 2010, Newman *et al.* 2009), but also transforming and evolving the previous urban conditions.
In this view green infrastructure can assume a strategic role in integrating actions to restore and enhance the ecological and environmental livability in urban areas, increasing the adaptive capacity of urban systems in term of resilience, climate change adaptation and reduction of their ecological footprints, enhancing security and life quality.

1.2 GREEN INFRASTRUCTURE AS ECOSYSTEM SERVICES

The ecosystem services (ES) gathered a wide range of environmentaland cultural aspectlinking biodiversity, ecology, economics and human wellbeing (Gómez-Baggethun *et al.* 2010). In the late 1990s the ES concept began to receive ample attention in literature (Baskin 1997; Costanza *et al.* 1997; Daily 1997).
The green urban infrastructures are an important element of the concept of ecosystem services (The Millennium Ecosystem Assessment - MA, 2005; and The Economic of Ecosystem and Biodiversity report - TEEB 2010). Studying cities as ecosystems within the new paradigms of ecosystem science (Pickett *et al.* 1992, Flores *et al.* 1997), we need to consider both raise the ecologic functionality concept and the human actions that influences on ecosystems; the study should use approaches developed in the social, behavioral, and economic sciences. In fact human perception, choices, and actions are often the phenomena that drive political, economic, or cultural decisions that lead to or respond to change in ecological systems. Ecosystems supplied to humankind benefits from a multitude of resources and processes, known as ecosystem services. They include many products and processes impacting on our global footprint that can be grouped into the following categories: provisioning, such as the production of food and water (including agro-ecosystem); regulating, such as the control of climate and disease; supporting, such as nutrient cycles and crop pollination; and cultural, such as spiritual and recreational benefits (Millennium Ecosystem Assessment 2005). In this view the UNEP in COP 10 Decision X/2 promotes the Strategic Plan for Biodiversity

2011-2020 to develop the landscape ecosystem and their contribution for quality of urban areas and the EU define an integrated view in Resolution on Our Life Insurance, Our Natural Capital: an EU Biodiversity Strategy to 2020 (2011/2307(INI). Urban ecosystems, such as urban 'green and blue spaces' may have a crucial role in building the necessary capacity to cope with environmental changes. In many cities in the world – New York, New Orleans, Singapore, Cape Town, and in Europe Copenhagen, Amsterdam, Barcelona, Berlin, Rotterdam, Salzburg, Stockholm, Turin, etc. – investments are made in tree planting, 'green roofs', urban agriculture and ecological restoration projects. Those actions are now growing rapidly as part of a low-carbon strategy to increase the capacity to adapt to climate change (i.e. URBES European network, Urban Biodiversity and Ecosystem Services: focused on quantifying and valuing urban ecosystem services incorporated into urban planning and policy). The role of the city's green infrastructure for the enhancement of local ecosystems (parks, gardens, woodlands and wetlands, social hortus) (Barthel, Parker and Ernstson 2013) developing resilient communities in the construction of ecosystems and landscapes has been already explored at Resilient Cities 2012.
In this view we will present a case study for developing the agro-ecosystems for river management in the urban environment of Turin.

2 CASE STUDIES

We will discuss the contribution of the green infrastructures for enhancing the ecological services in the management strategies of Turin metropolitan area aimed at resilient and sustainable development. The City of Turin decided to develop two interlinked programs aimed at a cross scale creative and conservative enhancement of the socio-ecological system:

a) River Contract of Stura, a river system strategic action aimed at evolving the environmental quality and security of the river basin. It can be defined as a 'green and blu contribution' for resilience in the North part of the Turin City, integrated in the Green Hearth (Corona Verde);
b) a new projects Turin City to be cultivated (TOCC -Torino Città da coltivare) aimed at enhancing agro-ecosystems, involving the North Part of Turin Metropolitan area (from Stura River to the urban fringes).

The Stura River Contract is an innovative method of territorial governance, useful in identifying shared strategies, actions and rules for the environmental, landscape and socio-economic enhancement of a river basin. The River Stura Basin in the Turin Metropolitan Area is a complex territory affected by different territorial practices: private, public and illegal cultivations, nomad settlements, abandoned and underused public spaces and parks, productive activities and peripheral urban areas, characterized by a mixture of density of these different urban space and uses.
The Stura River Contract promotes the sustainable innovation of territorial practices, starting from the participation of the institutional and social stakeholders in the river basin management. It contributes to rebuild knowledge and the self-defining skills associated with hydrogeological safeguard, the ecological development of the river and its landscape (creation of the ecological network), and the development of multifunctional agricultural practices; this is achieved by reactivating multi-level management of basin communities and enabling people to recover rivers; furthermore, it will help to generate new urban and rural territoriality, set up a network of local initiatives, and create integrated territorial enhancement policies. It is a creative tool for local ecological and community development, enforcing the institution capacity building to preserve the green urban areas. Besides it contribute to the realization of green ecological networks (river reforestation, biological agriculture), creating a great permeable defense from floodings.

In the same areas, affecting many part of the basin territory and the urban high density borders and fringes within natural riverscape, the City develops the Turin City to be Cultivated project (TOCC, proposed by the City Council in 2012). TOCC proposes a new relationship between agriculture and the city. The project aims to promote the development of agriculture in the urban environment: sustainable farming, addressing the concept of "short-chain" and social agriculture, promoting individual or collective horticulture and farms, and urban reforestation. TOCC responds to the evolution of the actual social-economic crisis, helping people to sustain families in alimentary supplies and local institutions to manage the green and rural urban areas.
The project TOCC initiates an analysis of the existing green areas used for agriculture , with a census of existing buildings, existing land concessions, as well as land owned by the city (two million square meters) and the other owned by private property. The local administration also identifies the most suitable areas for the promotion of forms of multifunctional agriculture and urban forestry. TOCC encourages the practices that recognize the food values, but also the social, environmental and soil conservation values related to farming (addressing Common Agricultural Policy and International URBES policies on urban ecosystem services).
The aim of TOCC is the creation of a new resilient model of urban living that is more linked to the earth and nature, directly involving communities in management (social hortus). It has positive economic consequences for those who live in the city and it is also a solution to the poverty problems for weak social actors. It contributes to ecological production of food and it can reduce the cost of managing the assets of urban green spaces. The challenge of the two innovative strategies is to design a city with natural smarter and resilient spaces that takes into account the various aspects of urban living such as local landscape, the social community development, and environmental management, helping to promote quality of the river fringes in an intense urban area, based on green and agricultural infrastructures.

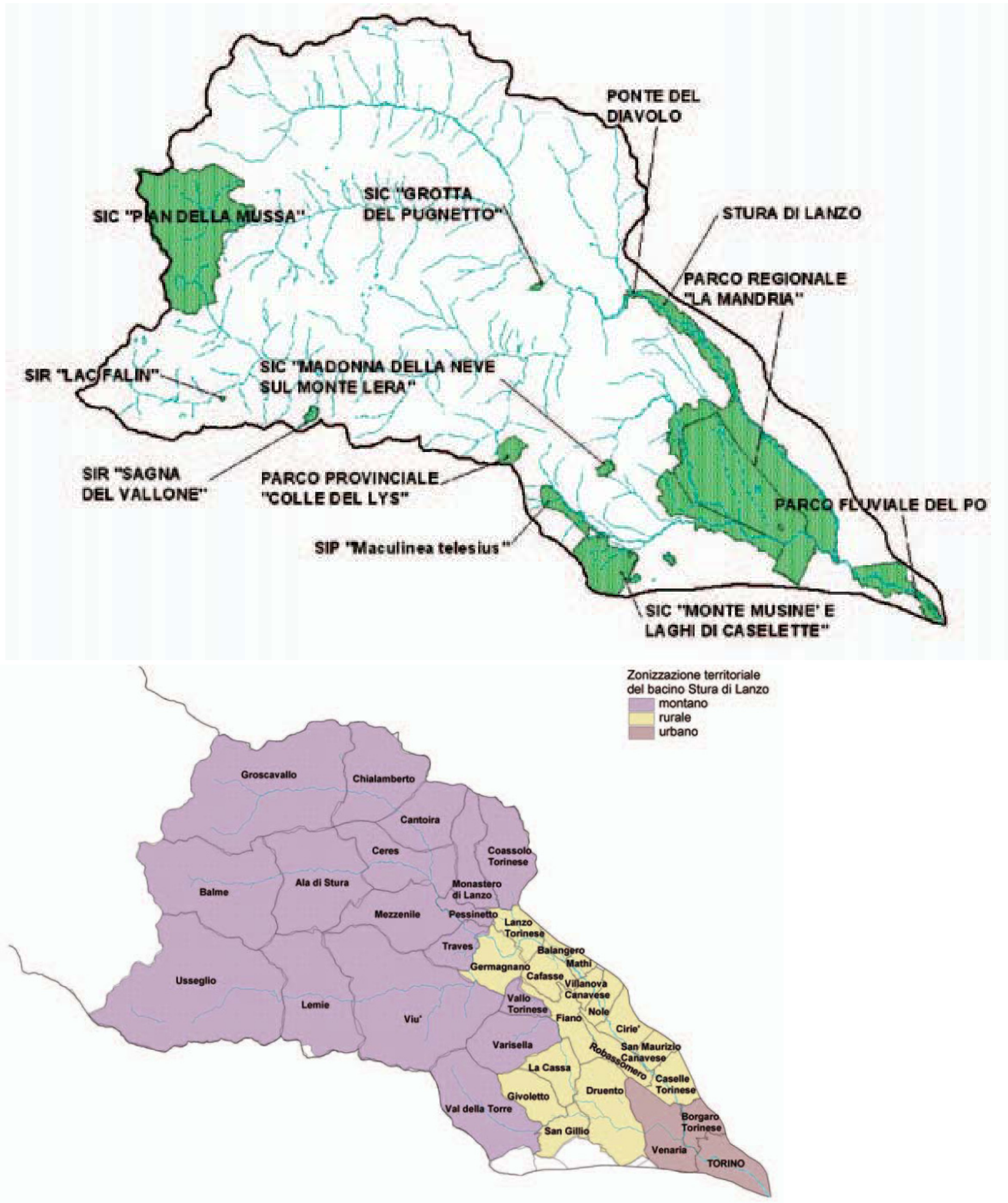
3 CONCLUSIONS. RESILIENT RIVER MANAGEMENT AND AGRO-ECOSYSTEM DEVELOPMENT

The Stura River Contract Strategy and the correlated TOCC Project will contribute to resilience starting from green and agricultural infrastructure valorization. In fact the two planning strategies develop agro-ecosystem in the urban environments that can be defined as "(natural) ecosystems that have been deliberately simplified by people for purpose of the production of specific goods of value to humans" (Swift et al., 2004: 121). We should consider that those green and agro-ecosystems are both consumers and providers of different ecosystem services with many differences depending on the management system adopted:

- the main natural ecosystems (green infrastructures) provided ecosystem services to agriculture that include pest control, pollination, regulation of water quantity and quality, and soil fertility (Power 2010; Swift *et al.* 2004; Zhang *et al.* 2007);
- Agriculture provides also carbon sequestration, genetic diversity, soil retention, regulation of soil fertility, nutrient cycling and water (Power 2010; Ribaudo *et al.* 2010);
- Agriculture contributes also to cultural services, such as aesthetic values, recreation and ecotourism (MA 2005);
- Agriculture in urban areas contributes to sustainable economic development of farmers and also of hortus communities, resolving the green management and the food needs (especially for poors).

Green and agro-ecosystems can also be managed to support biodiversity in order to produce an amount of economic compensations (Ruto and Garrod 2009) of human activities, especially in urban metropolitan areas, constructing an adaptive socio-ecological development that affects climate change, reduction of urbane ecological footprints, enhancement of security and life quality.

The study cases show local actions for solving ecological, social, and economic problems, developing strategies to anticipate changes. The riverscape enhancement and the agriculture development are the answers to the current needs for quality living and security. They are also an innovation of the urban system and of its trajectories. They will contribute to resilience absorbing and contrasting ecological and socio-economic crisis, developing the cultural system and its organization capacity, and extending the capacity of the system to learn and adapt to external disturbances and processes.



Figg. 1a / 1b The Stura River Contract in Turin Metropolitan Area: the fluvial areas, the natural parks, the institutional framework

Fig. 2 The latter an example of TOCC project related to urban hortus

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ITS SYSTEM TO MANAGE PARKING SUPPLY

CONSIDERATIONS ON APPLICATION TO THE “RING” IN THE CITY OF BRESCIA

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ABSTRACT

Brescia’s downtown is outlined by link roads built up at the Venetian walls, known as “Ring. The “Ring” is characterized by high traffic flows, as well as by the presence of several paid parking lots located on and off street. Furthermore, several facilities are located on these link roads. Nowadays city of Brescia is equipped with an ITS system able to manage off street parking spaces, allowing the share of information about parking availability to potential users, through the use of variable message panels. The parking supply issue and its management are strongly felt by citizens, as well as many other cities communities, whether European or not. This contribution aims to encourage an integration of the existing ITS system for the off street parking management with additional devices, which allow to manage also the on street paid parking supply located on “Ring” roads. The minimization of so-called “shared traffic” component of traffic flows, as well as the increase of road safety, in the context of a medium-sized Italian city are the main objectives of the ITS system integration. ITS asset chosen for the Brescia case study springs from the analysis of some non-European experiences about on street parking management (for example, San Francisco and Boston) and certainly can be considered suitable for the parking supply management of the whole city. It could become the main starting point in Italian cities for the application of performance based parking pricing, widely experienced in many U.S. cities.

KEYWORDS

ITS, smart parking, parking management, sensors, information

1 SMART CITY AND SMART PARKING

The term “Smart city” nowadays is widely used referred to all design and management aspects of city facilities. Activities related to “Smart mobility” aim to meet the needs of the transportation users, in terms of efficiency and environmental sustainability. The use of the Intelligent Transport Systems (ITS)[1] is fully recognized as an integration between the needs of the transportation sector and telecommunications devices. The ITS acronym is recalled in the most recent European and Italian regulation referring to systems defined as advanced applications which aim to provide innovative services relating to different modes of transport and traffic management, without being endowed with intelligence in the proper sense. ITS systems also enable users to be better informed and make the use of transportation networks safer, more coordinated and more intelligent[2]. The main purpose of ITS systems applied in transportation field is to increase safety (in terms of protecting the life of people) and security (in terms of vehicles protection).

In current ITS framework, some systems available on the market are specifically aimed to manage the transport of people. These systems differ primarily on the objective to be pursued and on their influence (direct or indirect) on mobility.

Among these, the ITS systems can be subdivided into the following categories:

- Advanced Traveler Information System (ATIS), designed to directly influence the choice of travel thanks to the real time traffic information;
- Advanced Driver Assistance System (ADAS), designed to influence the running of the vehicles in terms of speed and route;
- Advanced Traffic Management System (ATMS), conceived to indirectly influence the choice of travel thanks, for example, to the management of traffic light cycles;
- Advanced Travel Demand Management System (ATDM)3, engineered to directly affect the times of displacement and the mode of transport;
- Advanced Public Transport System (ATPS), applied to the transport demand/supply, integrating the monitoring of vehicles positioning and the real time information to users.

The current use of Advanced Parking Management Systems (APMS) is included in the ATDM category mentioned above.

As regards Italian regulation, the European Directive 2010/40/UE has been implemented in February 2013[4], anticipated by “Decree Growth”[5]. It sets the need to ensure the largest possible nationwide diffusion of ITS systems, assuring their efficiency, rationalization and cheapness of usage. Furthermore, it’s mentioned the necessity of the availability of free information about road facilities and traffic. In February 2014, the

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1 Bruno Dalla Chiara *et alii* (2013)

2 Directive of the European Parliament and of the Council 2010/40/UE of 7 July 2010 on the framework for the deployment of Intelligent Transport System in the field of road transport and for interfaces with other modes of transport.

3 The Transport Demand Management (TDM) discourages the use of the individual motorized transport, through “push” policy (i.e. parking pricing schemes, parking time limits) or “pull” policy (in terms of actions for the improvement of the quality of public means of transport).

4 Decree-Law of 1 February 2013 “Diffusione dei sistemi di trasporto intelligente (ITS) in Italia”, G.U. n.72 of 26 Marzo 2013.

5 Art.8, par.9 in Decree-Law n.179 of 18 October 2012 “Ulteriori misure urgenti per la crescita del Paese”, G.U. n.245 of 19 October 2012, ordinary Supplement n.194 (converted with amendments by Law n. 221 of 17 December 2012, G.U. of 18 December 2012 n.294, ordinary Supplement n. 208).

Ministry of Infrastructure and Transport adopted the national “Action plan” for the ITS[6] systems, stating priorities, timing and implementation tools.

UNI and ISO regulations should be considered as a reference to the technical compliance of ITS devices.

2 ITS SYSTEM FOR PARKING MANAGEMENT

Since 70s in Japan and Europe some systems for the reduction of traffic congestion have been already widely introduced[7]. These kind of systems were used to facilitate the choice of the parking lot mostly in the historical city centre. The spread of ITS system for parking management over the past years has been possible thanks to the recent technological development.

The Federal Highway Administration (FHWA) has given some operative indications regarding the installation of ITS systems. The first one highlights the need to integrate the APMS (Advanced Parking Management Systems) in a more complex ITS architecture built up at regional level, in order to make data collection and information communication more effective. The second recommendation reminds to verify the presence of communication supports and power supply during the design phase, even if the hardware and software devices are often characterized by limited size, energy independence and wireless data communication. As a matter of fact, the lack of continuity of functioning decreases the credibility of the system and the acceptance by users, who could consider communicated information not reliable. The FHWA therefore recommends to clearly establish the responsibilities of the involved authorities in relation to the maintenance and management of installed systems.

2.1 ARCHITECTURE AND COMPONENTS OF THE SYSTEM

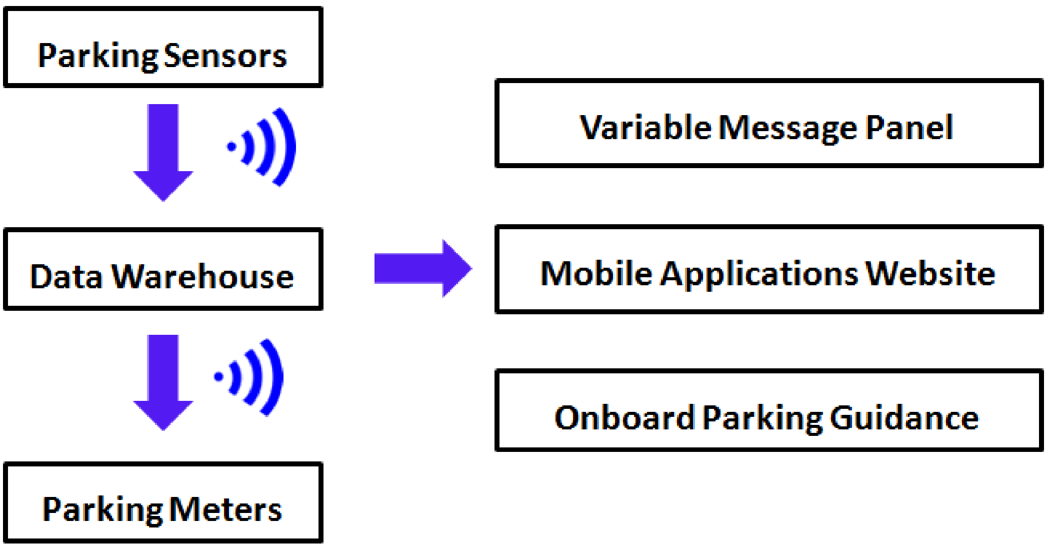

Fig. 1 System architecture for parking supply management

The Advanced Parking Management Systems (APMS) are usually composed by the following components:

- Sensors: they are used to collect the number of occupied parking spaces (on and off street) and to control cars presence. Focusing on data collection process, nowadays the sensors available on market can be differentiated by their technology: one is based on optical technology and the other on

6 Ministerial Decree n.44 of 12 February 2014 “per l’adozione del Piano di azione nazionale sui Sistemi Intelligenti di Trasporto (ITS)”, implementino Directive 2010/40/UE, cit.

7 In reference to a study of Federal Highway Administration (FHWA), 2007

magnetic/ultrasonic one. The first type is composed by a camera with CCTV images and a software, able to distinguish the presence of a car in the parking space. This kind of technology is more suitable for parking structures, because light conditions and weather are more stable. As a matter of fact, their use in parking structure makes the image processing by software more reliable. In relation to the architecture of cameras system, it's able to count the number of vehicles entering and exiting the parking. If cameras are installed in correspondence of each stall it is able to provide for each parking spot the localized information to help users in their parking choice.

- The second type of sensor is based on non-optical technology. As many sensor are available on the market, it is necessary to choose the ones more suitable to the system applied to the considered parking lots (i.e., it is advisable to install different sensors for parking on the street than off street). The choice of the type of sensor is also affected by size, reliability, climate change adaptability and price. Those sensors can be divided into two categories: intrusive, if need to be installed directly under road surface; non-intrusive, if need to be only fixed on a stand.
- Magnetic sensors are able to detect a parked vehicle thanks to the variation of geomagnetic field. The collected data are sent to centralized processing system through wireless connection. These sensors are feed by a long-life battery (generally it lasts more than 5 years) and they are waterproof. Therefore, they can be used in several applicative solution (both on and off street parking lots).
- Software: data recorded by sensors need to be processed by a centralized system (hardware and software). The most commonly used softwares are used to: check vehicles entering and exiting the parking, identify available parking spaces, indicate the preferential route to get to parking lots, determinate the parking rate compared to its required performance. Nowadays these softwares are able to work in real time or at set time intervals. An appropriate database is required in order to ensure reliability of the outputs obtained by the software processing. As a matter of fact, data redundancy has to be guaranteed to avoid possible system temporary failing. Finally, the hardware needs to be provided with UPS, pc, cables, antennas, power pack installed in a centre manned for controlling the correct operation.
- Users information: the information systems can condition the choice of trip both before the departure and during the journey. As a matter of fact, in the former case it's possible to distribute the transportation demand in space and time of the day. It is possible thanks to information spread about the availability of free stalls, indicating their geographical location within the municipal area. While in the second case the information disclosed during the journey may announce for example the conditions of circulation, regulate traffic (indicating alternative routes and detours recommended) and warning of imminent danger (to allow users of reducing their speed and to adapt their behavior). Among information systems available on the market, Variable Message Panel (VMP), specialized websites and smartphone applications are the most used to manage parking availability. Furthermore, the use of on-vehicle integrated navigation system has been recently applied.
- The VMP is widespread in European and non-European countries, usually installed on the main and most congested roads both in urban and suburban areas. The type of device needs to be selected in relation to the kind of information composing messages with text and pictograms. In the specific case of parking information management, panels can be usually divided into "directional" and "proximity" respect to their function within the controlled area: the first ones (in Italy often characterized by white background) give information about direction to be followed to reach parking areas and the number of available parking lots; the second ones (often with blue background) are installed near parking area to inform if parking spaces and access are available.

- The choice of user route can also be conditioned by the development of specific websites and smartphone applications. The two interfaces need a similar architecture, to receive information from the same parking database and to increase their usability and effectiveness.
- Finally, recent technology development has allowed experiments of in-vehicle parking guidance system to help user to find the available parking lot. This device can indirectly affect and manage traffic flows: in-vehicle software receive processed data about traffic and parking availability to recommend the preferred (as the shortest and less busy) route to reach the chosen parking space.
- Payment methods: the characteristics of the chosen device determine the possibility to collect spaces payment information and to update parking fees. Among systems available on the market, it is advisable to integrate smart park meters, smartphone applications, specific websites and automatic plate recognition system inside ITS systems.
- Park meters have been the first kind of device used to pay parking (installed since 30s). Over decades, a technology evolution has undergone to make users able to pay with credit/debit cards and parking subscription card. The smart parking meter needs to be equipped with wireless continuous connection to the centralized processing system of parking data (wireless connection is recommended to reduce construction costs for facility).
- Furthermore, smartphone applications and websites are usually able to accept parking payment, but they are also characterized by high development and operational costs, as well as need to establish specific contracts with banks and telephone companies to allow money flow. From an operating point of view, the ease of information updating of both interfaces is strictly linked to the use of only one data source for parking fees, as well as for parking occupation rate. If the system collects and processes data in real time, applications and websites can be integrated with a new functionality, which allows users to book parking lot in advance.
- Finally, the use of automatic recognition plate system has recently begun to spread mainly for payments of off street parking. The system is composed by cameras installed at the entrance and exit of the parking area (or structure), which are able to automatically recognize each vehicle plate and to charge the cost of the car park on the users bank accounts, as well as on their credit cards.

2.2 CASE STUDIES AND BEST PRACTICES

San Francisco and Boston have been considered as best practices in parking supply management with ITS application.

San Francisco

- In 2011, the pilot program “SFpark” has been implemented in order to dynamically manage both on and off street parking supply of the city. The main characteristic of the project is the calibration of parking fees based on parking occupancy rate. The ITS system is shown schematically in the figure below.

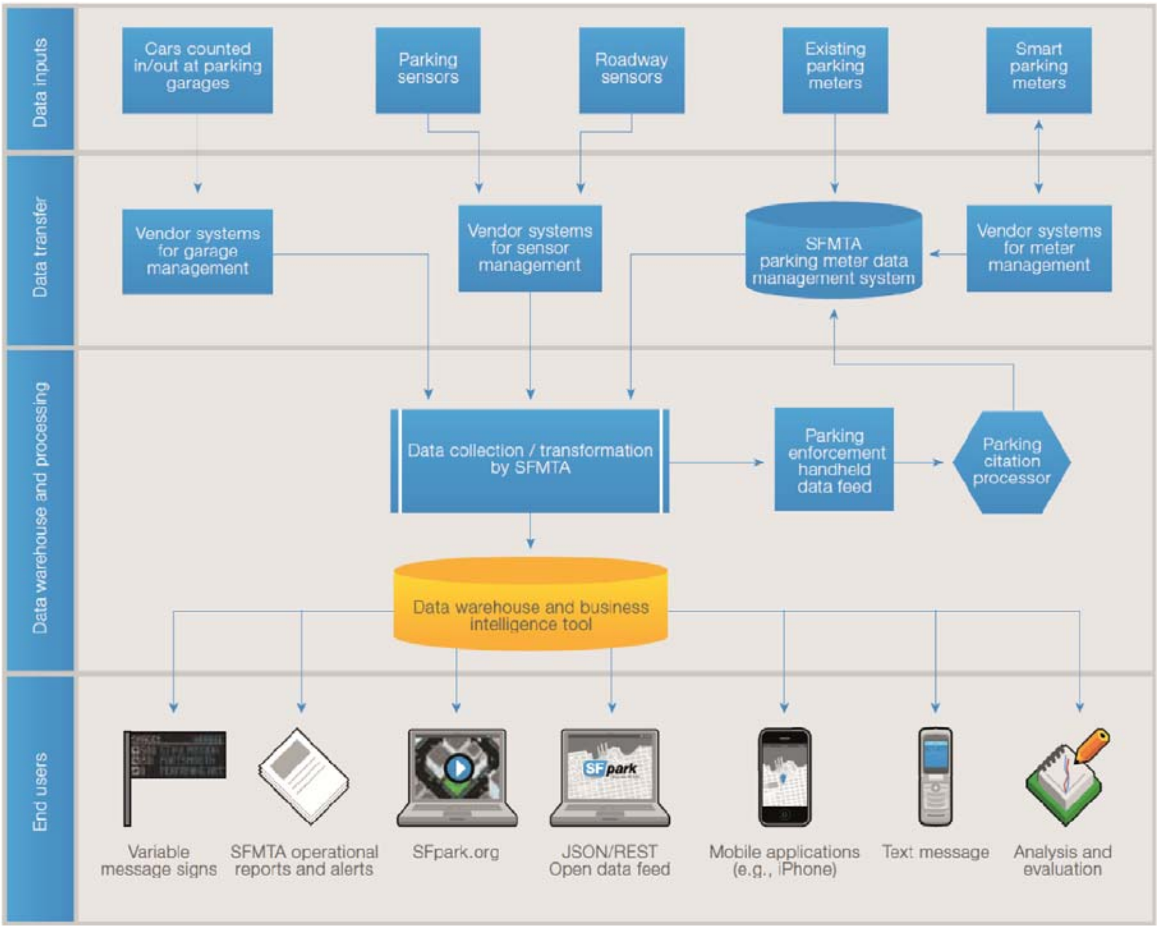

Fig. 2 Architecture of ITS system installed during “SFpark” pilot program in San Francisco

- After outlining the pilot area of the project within the city (namely neighborhoods Marina, Fisherman’s Wharf, Fillmore, Downtown, Civic Center, South Embarcadero, Mission Port of San Francisco), magnetic sensors have been installed to monitor on street parking occupancy rate (one for each parking lot located on street) and also at the entrance and exit of parking areas and structures. Fees payment within the pilot area has been managed by new smart park meters, replacing old ones to accept payment with credit/debit card and to manage longer parking time limits. They are also able to collect payment transactions to update centralized data warehouse. These data are sent by wireless connection. During “SFpark” program implementation, several “single lot” park meters (more than 5000 devices) and “multi lot” [8] ones (covering more than 400 parking space) have been installed, characterized by an illuminated display to provide information about fees and time limits.
- The SFpark also included the development of a dedicated website to spread out real time information about the localization of available parking spaces. Furthermore, on the website, documents and reports about results, fees calibration and collected data are periodically published. Furthermore, two smartphone applications were developed replicating website information, as well as adding several static data about suggested itineraries to reach chosen parking spaces. They have been designed after traffic surveys. These information were provided in order to reduce the number of vehicles searching of available car parking space on the most congested roads.

[8] While the “single lot” meter is installed near one specific parking space and allows to pay only for its occupation, the “multi lot” one allows to pay for a block of spaces, usually for a maximum number of 8.

Boston

- In April 2013 the City Council of Boston approved a pilot program to manage parking supply and traffic flow within a newly built neighborhood so-called "Innovative District"[9]. The project included the installation of magnetic sensor for on street parking spaces and smart park meters. It was designed as a fundamental part of recent city level plan called "City of Boston's complete street strategy". The project aims to discourage the use of private motorized vehicle mostly for commuters' trips.
- The pilot project consisted in the installation of 330 magnetic sensors for on street parking lot along the main and most congested roads of the pilot area, 4 additional VMP to give information about the waiting time to reach parking spaces, as well as "multi lot" smart park meters replacing the old ones. Furthermore, a specific application was developed to widespread real time information about parking availability. The new ITS system has been integrated with the existing one, which is equipped with traffic control cameras and an operation centre (so-called Traffic Management Center). These new devices were chosen because their specifications could allow the city to apply a variable parking pricing project, to date under evaluation.

3 HYPOTHESIS OF ITS APPLICATION IN BRESCIA FOR PARKING MANAGEMENT

3.1 STATE OF THE ART

The city of Brescia is characterized by a nearly round shape of the historic center, surrounded by very congested streets, known as "Ring". These roads are one-way roadways with multiple lanes. The main paid street parking spaces serve the historical center, as well as the main attractors of traffic.
The so-called "Ring" has always been characterized by high values of traffic flows during peak hours of working days. This trend is shown by the traffic data collection attached to the "Brescia PGT" (the city urban plan). As well known, the traffic component due to the search of the on street available spaces need to be considered as an element of substantial importance while carrying out the traffic analysis.

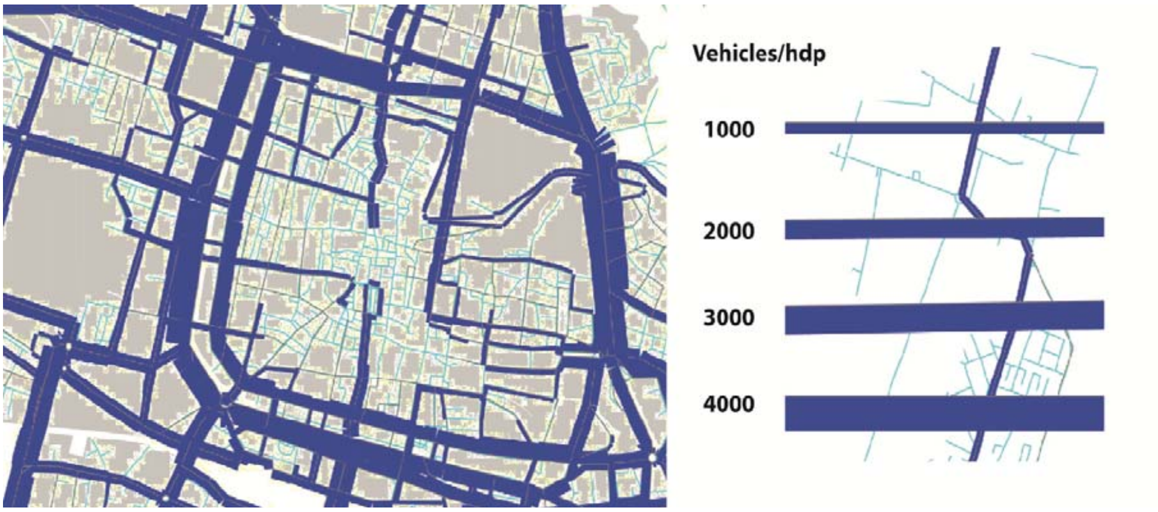

Fig. 3 Traffic simulation of the state of the art in the core of the city of Brescia

9 This district has been recently designed and built up (but not yet completed), in which several innovative projects from transportation and urban planning point of view have been implemented.

The main target is to focus a smart manage system and information channel for users on the existing parking system in the municipality of Brescia. The idea is to enlarge and complete the existing ITS system nowadays only dedicated to the off street parking.

As regards parking supply, the pilot area includes 13 parking structures, with a total of 6757 parking lots and in addiction 1792 on street paid parking spaces. In 2010 a manual site inspection was carried out to investigate the occupancy rate parking spaces located on streets. The results are shown in the following map.

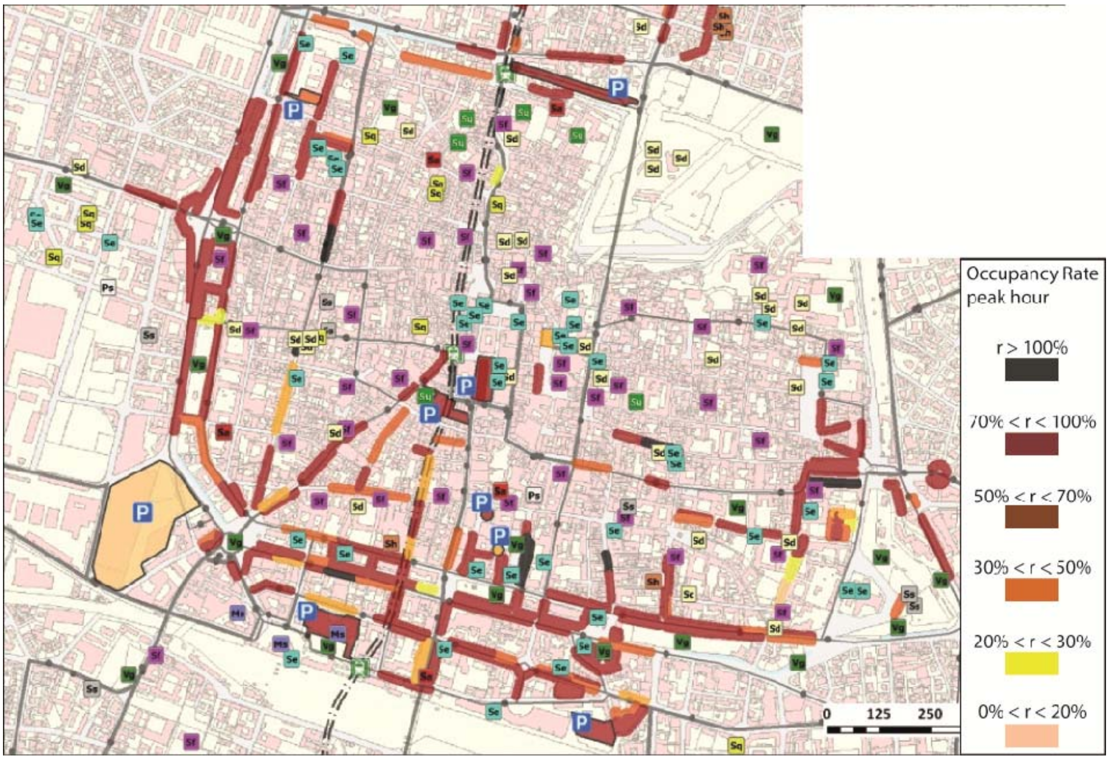

Fig. 4 Scheme of the occupancy rate of on street parking in the pilot area during the working day peak hours updated to 2010

Furthermore, the parking occupancy rate of the off street parking lots was update to 2013 (where available), as following.

Off street parking	Number of parking spaces	Occupancy rate - peak hour – working day [%]
Arnaldo	270	7,29
Autosilo	350	42,54
Benedetto Croce	72	38,89
San Domenico	72	61,11
Fossa Bagni	560	24,70
Freccia Rossa	2500	23,11
Piazza Mercato	190	78,61
Palagiustizia	570	83,57
Piazza Vittoria	450	88,72
Randaccio	180	52,83
Stazione	1000	62,78

Tab.1 Occupancy rate of parking structures in the pilot area during working day peak hours update to 2013 (Source: Brescia Mobilità S.p.a.)

The results reported above shown that the occupancy rate of on street paid parking spaces is on average higher and often near 100%. On the contrary, the occupancy rate of off street parking is very low, with the exception of three structures, namely Piazza Mercato, Piazza Vittoria and Palagiustizia: the first and the second are barycentric to the downtown, the third is near the law court of the city. The results follow those obtained in other countries.

The municipality since 1980 had decided to use VMP to give information to users about the road traffic. Thanks to the "Impiego VMP"[10] research program, it was possible to define the state of the art all over the municipal territory, localizing existing VMP network also including panels dedicated to off street parking information.

This research identified 3 main types of VMP in Brescia:

- "blue panel" (28 all over the city), located near parking structures indicating the accessibility to the car parking;
- "white panel" (39 all over the city), directional and informative ones concerning the number of spaces available in each off street parking;
- "standard panel" (11 all over the city), able to give several information (panel text and symbology) to communicate any kind of message, including available parking supply.

Brescia Mobilità S.p.a. is in charge to manage parking supply in Brescia. To reach this goal it has developed a website with information concerning available parking spaces and city mobility[11]. Furthermore, during the CIVITAS plus MODERN European project, two smartphone applications were developed to give real time information about off street parking available spaces.

The evident aim of this approach is to investigate and suggest a possible integration of the existing ITS system with new application, in order to manage both on street parking spots and real time information about their availability. The new ITS system aims to emphasize benefits given by a proper and complete management of parking supply and demand, in order to make urban areas of the city more livable for citizens. Thus, the high level objectives of this proposal consist in a reduction of traffic congestion, a reduction of air pollution and an increase of road safety.

3.2 PROPOSAL OF ITS SYSTEM TO MANAGE PARKING SUPPLY IN PILOT AREA IN BRESCIA

The project suggests to integrate existing ITS system for off street parking spaces with additional devices: magnetic sensors, VMP and smart park meters to manage on street paid parking.

Above all, the streets of the pilot area have been divided into homogeneous segments in regard to the placement and to the type of paid parking lots, in order to give more comprehensible information. Furthermore, the integrative ITS system includes new devices, as anticipated above:

- 1792 magnetic sensors for on street parking lots in the pilot area (one for each space) to collect and wireless communicate occupancy rate and localization of free parking spots. These devices have been suggested because they can be installed just below the road surface;
- new smart park meters, characterized by wireless connection to the operative centre in order to transmit all the parking transaction data; if possible it is advisable to modify the existing park meters hardware to allow continuous connection to the operative centre;
- new VMP (better "white" ones) in the pilot area to communicate parking availability to users.

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[10] This research has involved University of Brescia, University of Cagliari and Brescia Mobilità S.p.a.

[11] More information to date are available on the web site, for example the localization and availability of bike sharing, the bus and metrobus stops localization, their timetables, etc.

The new data can be processed thanks to exiting system, which manages the off street parking supply. The system architecture here suggested, once fully operational and suitably integrated to the existing one, would allow to receive reliable information updated in real time about the available parking spaces within the pilot area.

Furthermore, the outputs of parking data processing need to be spread through already existing and recently renewed smartphone applications and website.

The proposal of this study includes also the integration of new functionality to indicate suggested itineraries to reach the chosen parking lot. It's considered suitable for the city of Brescia, as the data flows have already been surveyed.

The monitoring phase of the effectiveness of the new ITS system is advisable to be carried out processing collected data remotely transmitted by traffic inductive loops already installed in the pilot area. This activity would allow to detect traffic variations after the calibration of ITS parking management system. This one would also allow to obtain environmental benefits, which can be evaluated through specific indicators of air pollution, even if the results are punctual. Those data can be collected through the pollutant stations already located near and within the pilot area. The significance of the parameters variations will be more evident if the ITS architecture would be enlarged to the management of whole parking supply of the city of Brescia.

Fig. 5 Traffic inductive loops and pollutant station already installed near and within the pilot area (localization updated to 2013)

Finally, the use of simple online survey would help the evaluation of the effectiveness of the new ITS system (i.e. asking users how often they follow the panel indication to choose the parking lot) and to collect actual users suggestion to improve both the website and smartphone applications.

3.4 EXPECTED RESULTS

After the evaluation of new and more complete ITS architecture here described, the city would be able to take into account the applicability of performance based parking pricing. As mentioned for "SFpark" pilot project, this is an innovative approach of parking management based on the definition of the maximum and minimum value of occupancy rate of parking spaces and on the possibility to calibrate parking fees respect to the actual occupancy rate itself. As a matter of fact, characteristics of the devices suggested allow to collect real time data information both on and off street parking and after data processing to inform and drive users to the preferential car park space.

4 CONCLUSIONS

The availability and occupancy rate of parking spaces have been considered as a problem since the size of the vehicle fleet has become such that the existing parking supply cannot always meet actual demand. Over the years, the increase of existing supply has been the only response. However, in the last decades several cities all over the world have set the goal of reducing traffic and increasing road safety, especially in urban areas. Therefore, the tendency is to act on the existing parking supply not enlarging it, but optimizing its management. Several experimentations and good practices for parking management (San Francisco and Boston are two of these) highlighted that ITS systems could allow to:

- indirectly manage the “shared traffic” component caused by who is looking for parking, also indicating the position of available spaces and less congested route to reach them;
- promote the use of specific parking spaces, especially those off street;
- monitor the occupancy rate of on street and off street parking spaces, to calibrate fees and optimize the use of parking supply;
- control payments, to reinvest collected amount both in parking management and in favor of citizens.

The good practices analyzed in this paper have also demonstrated that ITS systems for parking management need to be integrated with a larger-scale one for traffic management.

In this contribution Brescia, a middle-sized city, was considered as case study. The municipality is characterized by high motorization rate (more than national rate, equal to 621 passenger cars per 1000 inhabitants[12]) and high traffic flows, especially along link roads around the city center. The “Ring” has also got a large parking supply, located both on street (with occupancy rate often near 100%) and off street (with very low occupancy rate). The proposed ITS system, integrated with the existing one for parking management, could be considered a valuable tool for monitoring actual occupancy rate, calibrating parking fees and discouraging the use of on street parking.

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[12] The motorization rate is referred to year 2012, calculated as ratio between the number of passenger cars (data source: Automobile Club Italia - ACI) and inhabitants (source: National Institute of Statistics - ISTAT).

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IMAGES SOURCES

Figs 1,5: self elaborated

Fig. 2: San Francisco Municipal Transportation Agency (2011)

Fig. 3: Attachment – Traffic flows – State of the art - P.G.T. Urban plan of Brescia

Fig.4: Maffietti M. (2011).

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FORMAL ONTOLOGIES AND UNCERTAINTY

IN GEOGRAPHICAL KNOWLEDGE

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ABSTRACT

Formal ontologies have proved to be a very useful tool to manage interoperability among data, systems and knowledge. In this paper we will show how formal ontologies can evolve from a crisp, deterministic framework (ontologies of hard knowledge) to new probabilistic, fuzzy or possibilistic frameworks (ontologies of soft knowledge). This can considerably enlarge the application potential of formal ontologies in geographic analysis and planning, where soft knowledge is intrinsically linked to the complexity of the phenomena under study.

The paper briefly presents these new uncertainty-based formal ontologies. It then highlights how ontologies are formal tools to define both concepts and relations among concepts. An example from the domain of urban geography finally shows how the cause-to-effect relation between household preferences and urban sprawl can be encoded within a crisp, a probabilistic and a possibilistic ontology, respectively. The ontology formalism will also determine the kind of reasoning that can be developed from available knowledge.

Uncertain ontologies can be seen as the preliminary phase of more complex uncertainty-based models. The advantages of moving to uncertainty-based models is evident: whether it is in the analysis of geographic space or in decision support for planning, reasoning on geographic space is almost always reasoning with uncertain knowledge of geographic phenomena.

KEYWORDS

Formal Ontologies, Uncertainty, Geographic Knowledge, Probabilistic Ontologies, Possibilistic Ontologies, Fuzzy Ontologies

1 INTRODUCTION

Formal Ontologies have proved to be a very useful tool to manage interoperability among data, systems and knowledge. In the era of Big Data and Volunteer Geography Information (Goodchild, 2007), the issue of interoperability is definitely present and we need to face with several semantic problems. Ontologies can be used to solve these problems and help us to formalize knowledge in a more precise and explicit way. Many authors already applied ontologies to planning and geography domain (Fonseca et al. 2005; Caglioni et al., 2007, 2012; Ban et al., 2009; Murgante et al., 2011). It is part of human nature the desire to classify all the elements of nature, so that the elements of a same class correspond to similar properties. Unfortunately, in this wide and complex domain, we cannot strictly define a concept without considering uncertainty, vagueness, incompleteness, imprecision of the data and, more in general, subjective expert knowledge.

Our ability to precisely describe a system is an inverse function of its complexity (Bouchon-Meunier, 1994). Nowadays we are aware of the fact that the majority of geographic systems are complex by nature. Studying complex systems means to deal with data which can be vague (high cost), imprecise (measuring approximately 3 to 5 feet), affected by errors of various kinds (instrumental, methodological, statistical, human), ill-defined (strong pain), whose validity is not absolute (in 90% of cases) or with elements of knowledge which are intrinsically uncertain (experts think that, probably, tomorrow it will be rainy).

In the classical theory of measure we are conscious of the fact that the measure cannot provide valuable information on the judgment of the person who measures, but the latter is not sought after as it is considered spurious knowledge in regard to the phenomenon under observation. The main goal of the theory of measure is to assess the degree of imperfection of information provided within an objective measurement process. In the past, reference was made to the error theory, but this approach, based on the assumption of knowability of the "real value", given a long series of measurements (where frequencies approximate probabilities) and an underlying theoretical probability distribution, has its own flaws and cannot always been applied to many real world situations (especially when studying social systems). Today we refer to uncertainty approaches, based on subjective judgments by experts and sound mathematical theories, capable of dealing with such judgments. Subjective Bayesian probability theory has traditionally been the first attempt to overcome the assumptions of frequentist probabilities. However, even the methods based on Bayesian probability theory have their own limits in this regard, as expert knowledge does not always respect the stringent requirements of probability axioms. Newer theories have thus emerged in the course of decades.

Possibility theory, introduced in 1978 by L.A. Zadeh and subsequently developed by H. Prade and D. Dubois (1985), provides a framework that allows treating the concepts of non-probabilistic uncertainty, and gives the opportunity, within the same formalism, to deal with imprecision-related uncertainty. Zadeh is also the founder of fuzzy logic (1965), capable of representing gradual belonging of elements to a given set and of reasoning about gradual belongings.

Both possibility theory and probability theory can be seen as particular restrictions of a common and more general theory: the *evidence theory* of Dempster and Shafer (1968, 1976). According to this theory, an individual can make a judgment, assign a degree, with which he quantifies the evidence of a given atomic statement: this is the mass of belief that he would assign to that statement. More complicated statements are evaluated in two different ways. The degree of plausibility of the statement is the sum of the belief masses of all the atomic statements which are not in contradiction with it. Its degree of belief is the sum of the belief masses of all the atomic statements which are strictly included in the more general statement. The probability of the statement lies between its belief ant plausibility degrees. Whenever additive belief masses (which sum to one) cannot be determined, plausibility and belief degrees correspond to the possibility and necessity measures of possibility theory, and probabilistic triangular norm (product) and co-norm (sum) are replaced by possibilistic equivalents (min and max, respectively).

The use of imprecise, vague or uncertain knowledge leads to think in a more flexible way than what we could do with classical logic. In particular, probabilistic, fuzzy, possibilistic or evidential frameworks can respond to certain needs in geographic knowledge:

- treating intermediate values of truth between true and false absolutes;
- modifying the concept of quantifiers like universals and existentials;
- introducing into propositional logic probability, possibility, belief or truth of a statement;
- using new rules of inference, of reasoning, different from the *modus ponens* and *modus tollens* of classical logic.

In this paper we will show how formal ontologies, as well, can evolve from a crisp, deterministic framework (ontologies of hard knowledge) to new probabilistic, fuzzy, possibilistic or evidential frameworks (ontologies of soft knowledge). This can considerably enlarge the application potential of formal ontologies in geographic analysis and planning, where soft knowledge is intrinsically linked to the complexity of the phenomena under study.

1.1 UNCERTAINTY

Geographic Information Systems allow management of large information volumes about geographic objects, as administrative units, buildings, networks and natural environments, past and present. This knowledge is subjected to various forms of uncertainty, or imperfection if we talk about data (de Runz, 2008). If this uncertainty is dismissed in the representation of data, the validity of results, of the generalization process, and of relationships linking geographic objects can be questioned. Thus, uncertain information impacts the quality of analysis and decisions.

Referring to Fisher et al. (2005) and de Runz (2008), we can distinguish whether the classes of concepts are well or ill defined (Fig. 1). Cases where concepts and classes are well defined are more easily dealt with probabilistic approaches. We are often here in cases of shallow uncertainty (Walker et al. 2003), where a consensus exists on the probabilistic model to be used. In the other cases, concepts or classes are ill defined and data uncertainty is due to problems of inaccuracy or ambiguity. Typical modelling approaches to these medium or deep uncertainty situations (Walker et al. 2003) go beyond probability theory. Of course, the cases presented in the general scheme of Fig. 1 are pure, archetypical situations. Real case situations typically combine kinds of uncertainties, requiring hybrid and ad hoc approaches to knowledge modelling.

It should also be remarked that geographic knowledge goes well beyond geographic information. Data are only the starting point of geographic knowledge production. Much more often, geographers and planners are interested in knowing relations among phenomena. What is thus the relation among the development of a new highway network and the transformations of land-use within a given region? And what can the relationship be among the development of a new highway here and the transformation of land-use around a village 5 km away from here? These relations are often non deterministic in geographic space and eventual deterministic relationships can only be retrieved in an imperfect and messy form from the analysis of real world data. In many real case situations, even perfect data knowledge would finally result in uncertain knowledge about relations. However, this uncertain expert knowledge on relations among geographic phenomena, as well as uncertain information on empirical situations, are the bread and butter of the decision making process in urban and regional planning. Can formal ontologies provide more coherent ways of structuring this uncertain knowledge on geographic space? What kind of ontologies are better suited to facilitate knowledge interoperability (between experts and computer systems) and reasoning about this knowledge?

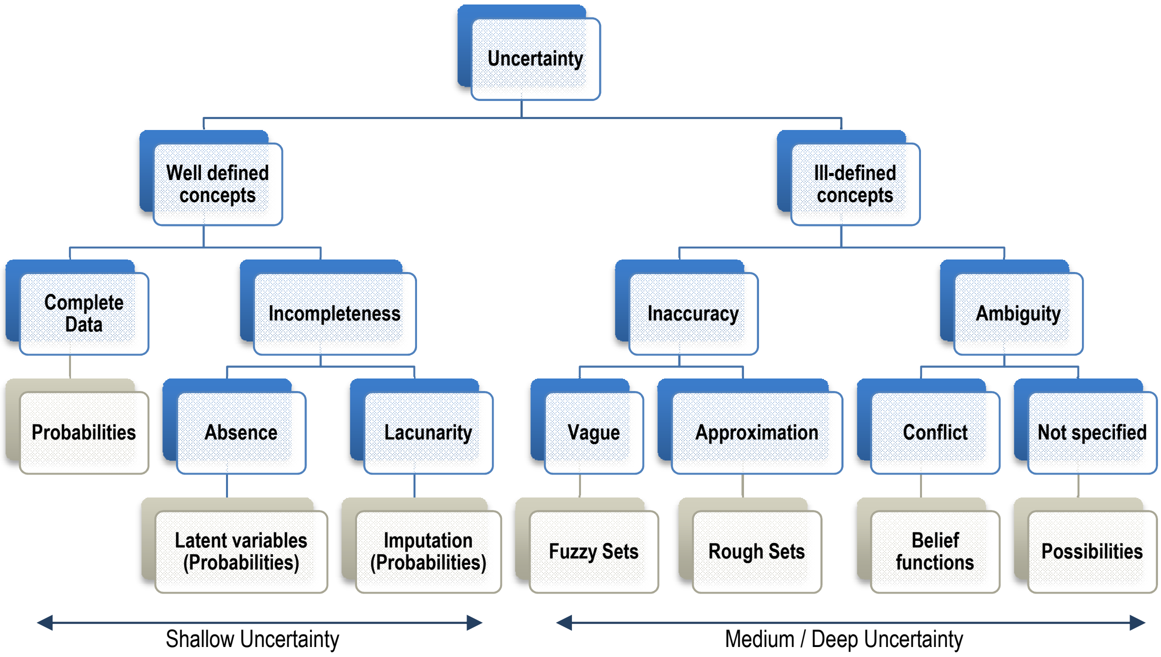

Fig. 1 Taxonomy of uncertainty in geographic information and suggestions of associated formalisms

2 UNCERTAINTY AND FORMAL ONTOLOGIES

Formal ontologies are traditionally been presented as a way to reduce uncertainty in the conceptualization phase, which is a prerequisite for geographic modelling. Through the definition of crisp concepts, medium and deep uncertainty situations can be avoided and residual uncertainty can eventually be captured through variance estimations in a given probabilistic framework. Relations among concepts are also modelled as crisp, whether dealing with taxonomies of concepts (relations like IsA, IsPartOf, etc.) or with more complex networks of relations (spatiotemporal relations, causal relations, etc.). This limits considerably the propagation of probabilistic uncertainty in modelling applications developed from such ontologies.

We don't deny the usefulness of crisp ontologies in order to eliminate unnecessary uncertainty linked to concept definitions. The problem is that geographic phenomena cannot always be conceptualised crisply and that conflicting conceptualisations could be an important component of certain domains of geographic knowledge. Moreover, relations among phenomena which are not simple taxonomies need different formal approaches (and even taxonomies could greatly benefit from non crisp ontologies). We thus need new kinds of formal ontologies capable of dealing with uncertainty, whenever uncertainty is not eliminable in the domain knowledge. Crisp ontologies should be considered as a limiting case of such soft ontologies.

Generally speaking, an ontology is an explicit formal specification of a shared conceptualization in a field of study (Studer et al. 1998). It is a conceptual model that adopts a formal protocol to enable the sharing of knowledge among experts in the field and between the latter and software. The use of formal ontologies concerns in two ways issues of uncertainty in geographical modelling.

First, ontologies define entities, properties and relations that characterize a given field of study in a formal language (including the OWL Web Ontology Language, compatible with the project of the Semantic Web). Reasoners compatibles with this language are then able to perform "automatic thoughts" with a first-order logic (more precisely descriptive logic). Imposing the use of such a formalism allows the modeller to eliminate a number of uncertainties in the conceptualization phase of his model, uncertainties associated with ambiguities, contradictions, the incompleteness in the definitions of objects, properties and relationships. Uncertainties associated with imprecise and vague definitions can be resolved in a formal ontology, but at the cost of simplifying the study domain in ternary predicates (true / false / unknown).

It is precisely to eliminate the artefact of a deterministic (or binary) logic, not really suited to model the fuzzy and uncertain relations in geographic systems, that new families of formal ontologies haves been developed: *probabilistic ontologies* (Ding and Peng, 2004), based on the language PROWL (Probabilistic Web Ontology Language, Costa et al. 2008); *fuzzy ontologies* (Abulaish et al., 2003; Straccia, 2006; Bakillah et al., 2011), based on the language Fuzzy-OWL; *possibilistic ontologies* (Loiseau, Boughanem, Prade, 2006) based on possibilistic logic (Dubois et al., 1994) and an extension of OWL language using annotation proprieties. These new ontologies are equally associated to new types of reasoners, which give us the possibility to perform automatic reasoning and classification of knowledge.

We don't want here to expose the precise formalisms of the three logics presented above, but we will present the three ontology families, which differ from the classical descriptive logic ontology, in order to better understand their main features and their advantages in formalizing geographic knowledge.

2.1 ONTOLOGY AND PROBABILISTIC LOGIC

Probabilistic logic combines the capacity of probabilistic theory to deal with uncertainty and the power of deductive logic in exploring knowledge structures. Probabilistic logic is a natural extension of traditional logic and it can be used in a wide range of application areas. Results of logical inference, or reasoning, are derived through probabilistic expressions, and above all laws of probability composition and Bayes theorem.

Bayesian Networks, also called probabilistic directed acyclic graphical models, implement Bayesian probabilistic logic and are powerful tools to represent probabilistic relationships between causes and effects. They have already been proposed as tools for modelling geographic phenomena (Fusco 2004, 2012). In their graphical representation variables corresponds to nodes of the network, and direct causal or influential relationships are represented as directed arcs between two nodes. The uncertainty of the causal relationship is locally represented by the conditional probability table, and it is described in Bayes' theorem. Under a conditional independence assumption, the graphic structure of Bayesian Network allows an unambiguous representation of interdependency between variables (Ding and Peng, 2004). Knowledge on geographic phenomena conveyed by Bayesian networks is hard to formalize with traditional crisp ontologies. This is the main reason that fostered the development of probabilistic ontologies.

Probabilistic ontologies can not only reduce the uncertainty in the conceptualization of the model, but also include all the elements of uncertain, subjective and incomplete knowledge in the study domain and assign a value of plausibility (in the form of a Bayesian probability). Probabilistic ontologies then become a sort of uncertain knowledge databases from which it is possible to develop models of probabilistic type, including Bayesian Networks. Ding and Peng (2004) applied a transformation of generic OWL in order to consider the directed acyclic graph of Bayesian Network in the structure of a formal ontology. This allows us to perform automatic reasoning in an ontology with a typical Bayesian Network structure.

2.2 ONTOLOGY AND FUZZY LOGIC

Fuzzy set theory and fuzzy logic were proposed by Zadeh (1965) to manage imprecise and vague knowledge. While in classical set theory elements either belong to a set or not, in fuzzy set theory elements can belong to a set to some degree, according to a membership function. For example, if we consider land use, a particular area belongs to the class "sparse settlement" with a certain degree 0.8, but the same area could belong to the class "agricultural land" with a degree 0.30, while in the crisp logic that area is to be considered either as sparse settlement or agricultural land with a degree 1. Moreover, crisp logic cannot really handle vague values such as the adjectives long, large, thick, far, close, etc. and modifiers such as the adverbs very, quite, almost, etc. These vague or fuzzy concepts can hardly be encoded in a Descriptive Logic Ontology, and unfortunately they look like to be the rule, rather than an exception, in geographical knowledge.

Memberships functions in fuzzy ontology can assume the classic forms like in fuzzy logic: trapezoidal or triangular functions, L-functions, R-functions, linear functions (see Fig. 2).

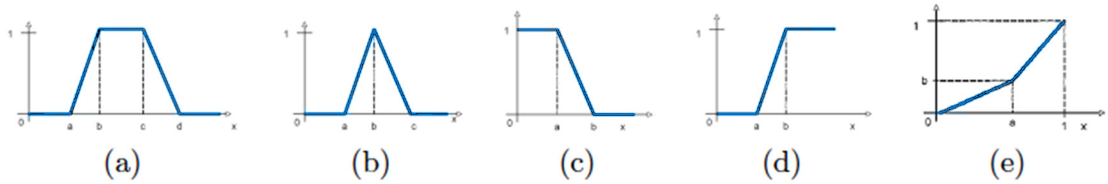

Fig. 2 Fuzzy OWL membership functions: (a) trapezoidal, (b) triangular, (c) L-function, (d) R-function, linear functions

A useful plugin of the formal ontology software Protégé has been developed in order to build fuzzy ontologies. This plugin is named Fuzzy OWL (Bobillo and Straccia, 2010) and it is associated to his fuzzy reasoner named FuzzyDL (Fuzzy Descriptive Logic). The same authors developed also another reasoner named DeLorean (DEscription LOgic REasoner with vAgueNess).

2.3 ONTOLOGY AND POSSIBILISTIC LOGIC

Several approaches have been proposed for dealing with uncertainty or vagueness in knowledge as we have seen above. However a large part of them are based on fuzzy logic, which completely departs from possibilistic logic (Dubois and Prade 1985, Dubois et al. 1994). Fuzzy logic deals with propositions involving vague predicates (or properties) and manipulates truth degrees, whereas possibilistic logic involves certainty and possibility degrees of truth, aiming at the epistemic side of uncertainty (expert subjective knowledge and evaluation of the certainty of this knowledge). The lack of complete certainty about the truth of a considered proposition is to be understood as a consequence of a lack of complete information.

A possibilistic logic proposition is a first order logic proposition with a numerical weight between 0 and 1, which has an upper bound in a possibility measure Π and a lower bound in a necessity measure N (Dubois et al. 1994). The relation between possibility and necessity of a proposition p is given by $\Pi(p) = 1 - N(\neg p)$. Necessity describes the certainty of the possibility measure.

Possibilistic description logics provide a flexible framework for representing and reasoning with ontologies where uncertain and/or inconsistent information exists. Qi et al. (2010) developed a possibilistic reasoner called PossDL (Possibilistic Descriptive Logic) Reasoner based on an evolution of Ontology Web Language. Annotated OWL has the possibility to add possibility and necessity values to relationships among concepts, and PossDL reasoner use a sort of possibilistic network (like in probabilistic ontology we can use Bayesian Networks) in order to infer knowledge.

A simple possibilistic taxonomy is proposed by Loiseau, Boughanem and Prade (2006) on the concept of “accommodation” and its synonymous or close terms (Fig. 3).
In the example in Fig. 3, the words like lodge and inn are only considered as possible synonyms, or as entities that can provide the same services. Nothing can be inferred for the necessity from the possibility degree only, it is always possible, for example, that some lodges are not inns. On the other hand, both necessity and possibility degrees between motel and motor inn are 1. These terms are considered as genuine synonyms.

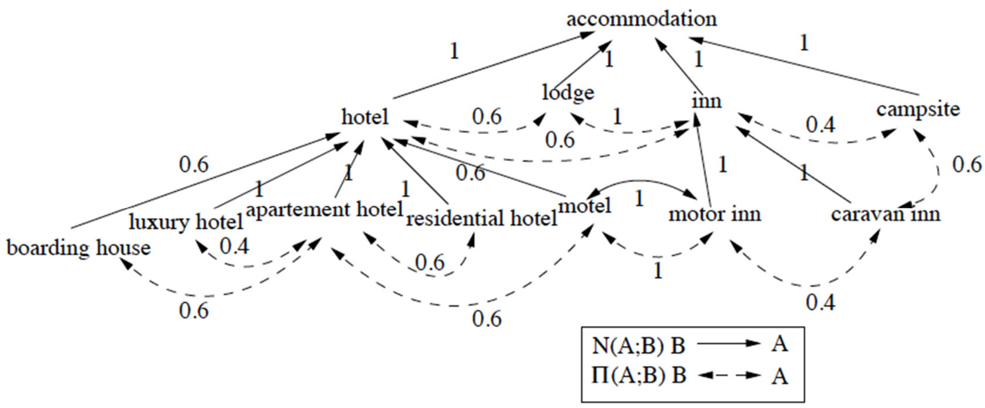

Fig. 3 Possibilistic taxonomy for Accommodation (Loiseau et al., 2006)

3 ONTOLOGY OF UNCERTAIN RELATIONS: AN EXAMPLE

We have seen that different kinds of formal ontologies can encode uncertain knowledge of phenomena and of relationships among phenomena. Through a simple example from the domain of urban geography, we want to show what kind of knowledge could be thus formalized and what are the advantages with respect to more classical crisp ontologies. Through this example, the reader will also better understand the difference between probabilistic and possibilistic formalization of uncertain relations.
After having formally defined the concepts of urban sprawl and of household preference for individual or for collective housing, we want to define a cause-to-effect relationship among the two phenomena.
The classical crisp ontology of this relationship (Fig. 4.a) would formalise a deterministic relationship. Of course, the formal ontology will have to encode in OWL whether the relationship only concerns preference for individual housing causing the true value for urban sprawl, or whether the relationship also foresees that preference for collective housing causes the false value for urban sprawl. These two different causal relationships correspond to two different truth tables for the deterministic relationship, as follows:

Simple causation : Pref. = Ind. Housing → Sprawl = True

	Pref. = Ind. Housing	Pref. = Coll. Housing
Sprawl = True	True	True
Sprawl = False	False	True

Double causation : Pref. = Ind. Housing → Sprawl = True
AND Pref. = Coll. Housing → Sprawl = False

	Pref. = Ind. Housing	Pref. = Coll. Housing
Sprawl = True	True	False
Sprawl = False	False	True

Tab. 1 Truth tables for the deterministic relation “Household Preference causes Urban Sprawl”

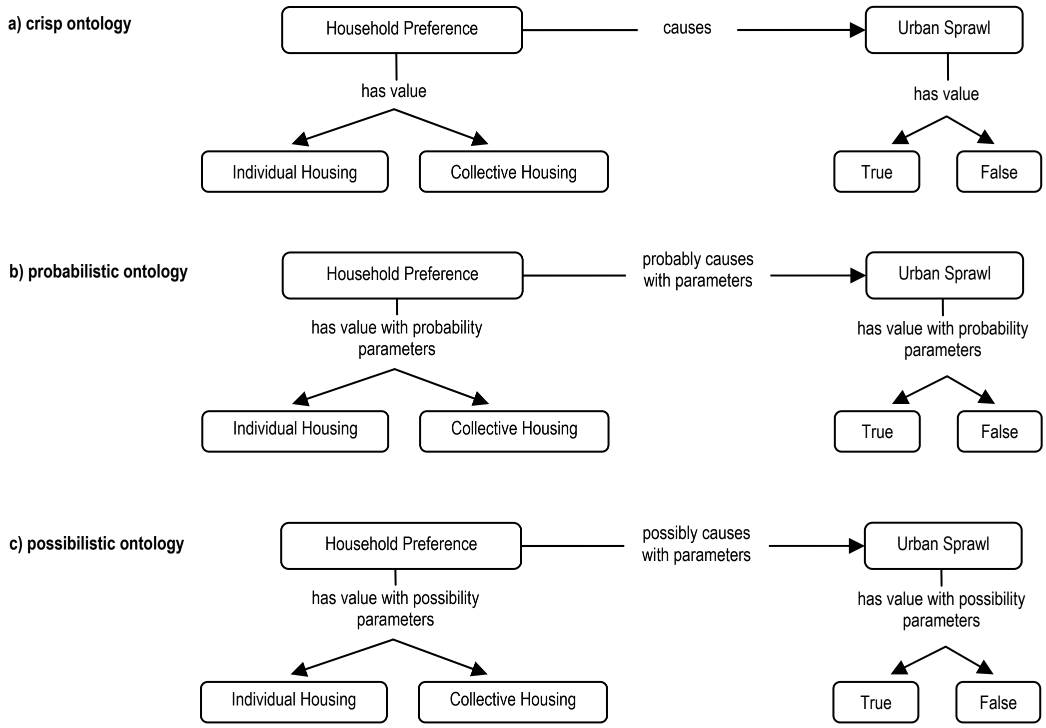

Fig. 4 Different ontologies for the relationship between household preference and urban sprawl

The knowledge encoded in either of these two tables seems to us particularly inappropriate for reasoning about real-world cases of relations between household preferences and urban sprawl, whether this is in the context of diagnostic analysis (did household preferences cause urban sprawl in the case studies?) or in predictive analysis in the context of spatial strategic foresight (will household preferences cause urban sprawl in the case studies?). Reasoners processing this ontology in OWL can only infer whether urban sprawl is true or not, whenever we have certain knowledge of household preference (and even to do this, the ontology has to encode the double causation). But what if we don't have certain knowledge of household preferences? Besides, even if the latter were known with absolute certainty, are we really sure that knowledge of urban sprawl would follow deterministically from it?

A Bayesian probabilistic knowledge of phenomena and relationships among them would naturally prefer a probabilistic ontology, like the one schematized in Fig. 4.b. The PROWL formalism could thus represent the concepts and the relations with the probabilistic parameters which are associated to their knowledge. Knowledge of household preferences would be modeled through a probability of it being "individual housing" and another probability of it being "collective housing", the sum of the two being 1, according to probability axioms. The cause-to-effect relationship of this phenomenon with urban sprawl would be formalized through four probabilistic parameters, making up a conditional probability table. Once again, causation can concern only one or both values of the Household Preference, as follows:

Simple causation : Pref. = Ind. Housing → Sprawl = True

	Pref. = Ind. Housing	Pref. = Coll. Housing
Sprawl = True	0.8	0.5
Sprawl = False	0.2	0.5

Double causation : Pref. = Ind. Housing → Sprawl = True AND Pref. = Coll. Housing → Sprawl = False

	Pref. = Ind. Housing	Pref. = Coll. Housing
Sprawl = True	0.8	0.3
Sprawl = False	0.2	0.7

Tab. 2 Conditional probability tables for the probabilistic relation "Household Preference causes Urban Sprawl with parameters"

Probability values in each column sum to 1, according to probability axioms. The probabilities linking values of cause and effect inform us both on the strength and the uncertainty of the relationship. The conditional probability p(Sprawl=True | Pref.=Ind.Housing) linking preference for individual housing to urban sprawl being true, is thus particularly strong (0.8, i.e. not too far from 1, which corresponds to a deterministic relation). The conditional probability of urban sprawl being false when households prefer individual housing (0.2 in the example) conveys information on the uncertainty of the causal relationship Pref. = Ind. Housing → Sprawl = True. Whether this uncertainty corresponds to an intrinsic variability of the effect of household preferences on urban sprawl (ontic uncertainty) or to our ignorance of other relationships between urban sprawl and phenomena (for example planning bylaws or availability of land for development) which are not in our knowledge base and which are capable of hindering sprawl even in the presence of preference for individual housing (epistemic uncertainty) is, for the moment, secondary to our argumentation.
Knowledge of housing preferences (whether certain or uncertain) and knowledge of the parameters of the conditional probability table, can easily be used by any PROWL reasoner in order to infer probabilistic knowledge on urban sprawl. Let's imagine that "soft" knowledge of household preferences is given by the probability vector [0.9 0.1], corresponding to individual and collective housing, respectively. Matrix multiplication between the conditional probability table (we will use the one of the simple causation) and this vector will give the probability vector [0.77 0.23] for urban sprawl being true or false, respectively. The PROWL reasoner would come to the following conclusion: urban sprawl is most probably true, but the uncertainty of this outcome (probability is still 0.23 for not having urban sprawl) is higher than the one for households preferring individual housing, as uncertainty was increased through the use of the knowledge of un uncertain causal relationship.
Possibilistic knowledge of phenomena and relationships would instead prefer a possibilistic ontology, like the one schematized in Fig. 4.c. Here, knowledge of household preferences would be modeled through possibility measures of it being "individual housing" and of it being "collective housing". The latter corresponds to 1 – N (individual housing), according to possibility theory axioms, and conveys information on the uncertainty of the possibility of preferences being "individual housing". The cause-to-effect relationship of this phenomenon with urban sprawl would be formalized through four possibilistic parameters, making up a conditional possibility table. In the case of simple causation between preference for individual housing and urban sprawl, we would have:

Simple causation : Pref. = Ind. Housing → Sprawl = True

	Pref. = Ind. Housing	Pref. = Coll. Housing
Sprawl = True	Π (Sprawl | Ind.Hous.)	Π (Sprawl | Coll.Hous.)
Sprawl = False	Π (¬Sprawl | Ind.Hous.)	Π (¬Sprawl | Coll.Hous.)

	Pref. = Ind. Housing	Pref. = Coll. Housing
Sprawl = True	1	1
Sprawl = False	0.3	1

Tab. 3 Conditional possibility table for the possibilistic relation "Household Preference causes Urban Sprawl with parameters"

How can we read this table? The first column formalises the simple causation: whenever households preferences go to individual housing, it is wholly possible (possibility = 1) to cause sprawl, but this causal relationship has an uncertainty of 0.3 because this is the value of the possibility of sprawl being false even in the presence of preferences for individual housing. The second column formalises the absence of relation when household preference goes to collective housing (it corresponds to the 0.5 0.5 probabilities of the second column in table 2): both urban sprawl and its absence are wholly possible (and hence completely uncertain) when households prefer collective housing.

A PossDL reasoned could use the knowledge of housing preferences and of the parameters of the conditional possibility table, to infer possibilistic knowledge on urban sprawl. Let's imagine that possibilistic knowledge of household preferences is given by the vector [1 0.2], corresponding to possibilities for individual and collective housing, respectively. Max-min composition rules between the conditional possibility table and this vector will give the possibility vector [1 0.3] for urban sprawl being true or false, respectively. This means that urban sprawl is wholly possible (possibility = 1) but its uncertainty is 0.3. Once again, uncertainty of the conclusion that sprawl is possible is higher than uncertainty of the premise that households prefer individual housing: this is the consequence of the use of a relatively uncertain (possibilistic) causal relation.

4 CONCLUSIONS

Reasoning on uncertain geographic knowledge, formalized through uncertain ontologies, whether probabilistic or possibilistic, is able to convey a coherent uncertainty measure of inferred knowledge. The applications presented in this paper are of course just examples of the modeling potential of uncertain formal ontologies. Domain knowledge encoded in such ontologies can be seen as fragments which could eventually be retrieved in the Semantic Web and combined by modelers (either human or software) and used as building blocks of more complex models: Bayesian probabilistic networks, fuzzy Bayesian networks, possibilistic networks, etc. Costa et al. (2008) thus propose to use PROWL ontologies in order to support the development of multi-entity Bayesian networks.

The problem of an uncertain Semantic Web will eventually be the one of combining uncertain ontologies using different formalisms. Wang et al. (2007) use Dempster-Shafer and possibility theories in order to combine different (and sometimes contradictory) crisp ontologies through appropriate ontology matchers. The indication seems clear: it is through more general uncertainty theories that uncertain ontologies can be combined. Demptster-Shafer and imprecise probabilities theories could thus be used in order to combine crisp, probabilistic, fuzzy and possibilistic ontologies, as they are generalizations of the formal theories underlying these ontologies.

Beyond these methodological perspectives, we believe that the application potential of uncertain ontologies to geographic knowledge is huge. Classical crisp ontologies have already proved of great help in insuring data interoperability among geographic models and applications (like in GIS and web-based GIS). Uncertain ontologies can be the preliminary phase of more complex uncertainty-based models. The advantages of moving to uncertainty-based models is evident: whether it is in the analysis of geographic space or in decision support for planning, reasoning on geographic space is almost always reasoning with uncertain knowledge of geographic phenomena.

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IMAGES SOURCES

Figg. 1, 4: Caglioni and Fusco (2014), University of Nice Sophia Antipolis, UMR7300 ESPACE

Fig. 2: Bobillo and Straccia (2010), Fuzzy OWL plugin for Protégé.

Fig. 3: Loiseau et al. (2006) Evaluation of Term-based Queries using Possibilistic Ontologies.

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GEODESIGN FROM THEORY TO PRACTICE: IN THE SEARCH FOR GEODESIGN PRINCIPLES IN ITALIAN PLANNING REGULATIONS

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ABSTRACT

Geodesign is a trans-disciplinary concept emerging in a growing debate among scholars in North America, Europe and Asia with the aim of bridging the gap between landscape architecture, spatial planning and design, and Geographic Information Science. The concept entails the application of methods and techniques for planning sustainable development in an integrated process, from project conceptualization to analysis, simulation and evaluation, from scenario design to impact assessment, in a process including stakeholder participation and collaboration in decision-making strongly relaying on the use of digital information technologies. As such, the concept may be not entirely new. However, it is argued here, its application have not reached expected results so far. Hence, more research is needed in order to better understand methodological, technical, organizational, professional and institutional issues for a fruitful application of Geodesign principles and method in the practices.

In line with the above assumptions, this paper is aimed at supplying early critical insights as a contribution towards a clearer understanding of the relationships between Geodesign concepts and planning regulations. The auspice with this first endeavour along this research issue is to make a more explicit and robust link between policy principles and planning, design and decision-making methods and tools, possibly as a small contribution to bring innovation in the planning education, governance and practice.

KEYWORDS

Geodesign, urban and regional planning regulations, Strategic Environmental Assessment.

1 INTRODUCTION

Since the middle-Eighties in Italy, territorial governance faced an evolution towards more environmentally savvy approaches to urban and regional planning. Besides environmental sustainability, transparency, communication and participation are all components of further innovation to the planning paradigms towards a broader scope in sustainability of development. In the last decade at the European level, the Directive 2001/42/EC on Strategic Environmental Assessment (SEA) was transposed in national and regional legislation frameworks introducing a new approach and shifting the scope of urban and regional planning towards decision-making processes aiming at governing territorial development according to sustainability principles. However, many pitfalls have been reported in the SEA application in Member States (Parker, 2007; COWI, 2009). Many of them can be found also in the SEA of spatial planning at the regional and local level, including -but not limited to- unsatisfactory explanation of how the environmental sustainability issues inform the plan options and in evaluating relevant impacts, unclear explanation of uncertainties and difficulties in analysis, and last but not least unclear impact of public participation in the decision-making process (Fisher, 2010). All this pitfalls may be related to the lack of a clear shared vision on how to implement SEA in spatial planning both in terms of principles, methods and tools.

In order to address these evident and common issues in a fruitful implementation of SEA in spatial planning, Geodesign, as a digitally aided design approach for the creation of change proposals and impact simulations in their geographic contexts (Flaxman, 2010), may support to bridge the gap between SEA policy principles and implementation in the practice with an operational methodology. This approach appears to be particularly actual with regards to the Italian spatial planning governance which recently faced innovation drivers thanks to the current development in regional Spatial Data Infrastructures (SDI), as enabling technical platform supporting spatial governance.

In the light of above premises the aim of this study is to analyse the Italian national and regional legislative framework and investigate where in the past and current regulations is it possible to find elements of coherence with the Geodesign principles, methods and tools in order to supply an explicit and clearer framework for its application.

The paper is organized as follows: the next section gives a clearer definition of Geodesign based on the literature review with the aim of supplying an operational framework for the following analyses. The third section illustrates the study methodology which focuses on the analysis of the relationships between the Steinitz' Geodesign Framework (GDF) (2012) and selected national and regional regulations shaping the planning process in Lombardy, Tuscany and Sardinia. The results of the analysis aim at making these relationships more explicit in order to reduce the gap between policy principles and their technical implementation. Current results does not pretend to be systematically exhaustive at the present stage of development, nevertheless they already offer some interesting critical hints for addressing the given issue.

As a matter of facts many concepts entailed in the Geodesign Framework can be found in past and current planning legislative frameworks defining the planning systems in many countries. To mention but one example, the exercise of Environmental Impact Assessment (EIA) which is central to the GDF, is concerned by United States' regulation since 1970 with the National Environmental Policy Act (NEPA). Similarly EIA was introduced in European environmental aquis since the middle-Eighties (i.e. Directive EIA Directive 85/337/EEC). On a similar vein, relationships between many concepts and methods, which found integration in the GDF, and normative rules defining the planning systems and procedures guiding the practice can be found in national and regional planning regulations. However, these relationships may not be always evident to the practitioners, thus creating weaknesses and pitfalls in their implementation. The reasons are many including the lack of reliable expertise (having this issue implications also with regards to planning education) and contextual socio-cultural and political settings (i.e. role of actors, level of rationality of the process, availability of data and tools, and the like). Thus, it is argued contributing to make a more explicit link between good planning and design methodology approaches and actual planning regulations may eventually help to achieve more effectiveness in the implementation of the underlying principles of a planning system.

2 THE EMERGING GEODESIGN PARADIGM

The term Geodesign, introduced by Jack Dangermond in 2005 to indicate the design activity in the geographic space, is relatively new (Artz, 2010). Nevertheless its application has long back origins. In fact, "any design-related activity which depends on or in some way changes the context of our surroundings can be considered geodesign" (Miller, 2012).

Geodesign employs a multidisciplinary and synergic approach to solving complex problems that involve not only territorial and environmental issues, but also social and economic concerns (Dangermond, 2010). Integration of different information in a design workflow, either at the local or at the global scale, is achieved through methods and tools borrowed from Geographic Information Science (GIScience - Goodchild, 2010; 2012). The growing interest in Geodesign is demonstrated by an increasing number of conferences and even more by many new curricula on Geodesign flourishing within the School of planning in the United States (Foster, 2013).

In order to apply Geodesign to regional landscape design studies Carl Steinitz recently synthesized (2012) a complete methodology framework oriented to understand how the context should be transformed. Steinitz's Geodesign Framework (GDF) represents a particular adaptive methodology for decision-making in urban and regional planning and design informed on (digital) spatial information. The framework enables the planning (or Geodesign) technical team to develop a holistic view of the multiple issues involved in a planning process and, using geospatial modelling and impact simulations, to get real-time feedbacks on the performance of alternative development scenarios in form of maps, charts and reports (Ervin, 2011). An example of this approach has been recently implemented by Campagna and Matta (2014) on the case study of the SEA of local land-use planning (LLUP) in Sardinia, which implements among other concepts Harris's (1989) idea of interactive sketch planning in Planning Support Systems, which is also central to Geodesign.

The core of the GDF relies on six models which allow designing future development scenarios and identifying the possible consequences of those changes, through territorial reference context description, analysis of its own dynamics and evaluation of its potentiality. The first three models describe the present situation of the territorial context: the Representation Model abstracts information into a set of digital spatial data layers, the Process Model combines them to describe how spatial phenomena evolve in time, and the Evaluation Model supports to explore which implications have these processes in the area. Then, in the light of the results of above analysis, the last three models describe how the territorial context could develop or become in the future: the Change Model delineates possible alternative options for transformation, the Impact Model evaluates the presence of beneficial or harmful impacts on natural and human environment deriving from those alternatives, and eventually the Decision Model help the stake-holders to express preferences on alternative and eventually to make a final decisions.

A complete Geodesign study should consist of three iterations along the six models: in the first iteration (i.e. scoping) the framework steps are driven from model one to model six and the intent is to understand the scope of the analysis; during the second iteration (i.e. metaplanning) models are conceived in reverse order with the aim to define in details how to carry out the study. Lastly, in the third iteration (i.e. implementation) the design/planning study method and models are carried out from the first to last one again. Linearity along the iterations is not strict and feed-back loops or shortcuts may be necessary several times before the study is completed. One of the elements that most make geodesign useful in terms of spatial planning is that analysis inform design since the early stage of planning process and goes along with it until the end in a not linear course enriching it through several iterative possible loops. With these respect the GDF shows a consistent logic with SEA which should be run since the early stages of the planning process in order to inform decision at any stage, and it may contribute to address many current SEA pitfalls encountered in the urban and regional planning practices (e.g. how to inform design alternatives). Moreover, in the emerging Geodesign debate its practical implementation is closely connected to the use of digital data and technology in planning and design, which since few years is slowly starting to characterize current planning governance and practices in Italy thanks to development in regional geographic information systems according to a Spatial Data Infrastructure paradigm.

3 METHODOLOGY AND CASE STUDY

This study springs from the assumption that design in geographic space, or Geodesign, may become a reliable way to drive the planning process towards more sustainable spatial decision-making and development processes. Many of the ideas underlying the concept of Geodesign are not new though, and references to them can be found looking back to the evolving urban and regional planning regulatory framework, and this is done here with regards to in the Italian planning system. Nevertheless, while the ideas may be already there, their practical implementation as discussed earlier often lacks to fulfill the underlying principles. To this end, understanding the relationships between methods and norms may help to ensure a more responsible and proactive application of the regulations. Starting from this assumption, the research methodology of this study involves a critical review of selected Italian national and regional planning laws in order to detect links to Geodesign key concepts into them. After a brief review of the evolution of the national planning legislation from a Geodesign perspective, the study focuses on three specific regional case studies: namely Lombardy, Tuscany and Sardinia. Hence, relating the six models of the Steinitz's GDF with each of them, existing (or missing) links are identified and analysed critically. The results are outlined in a summary matrix shown in the last section, which is aimed at contributing to put light on which issues are of particular relevance in order to properly take into account in integrated way Geodesign principles in the planning regulations. The final objective is to eventually contribute to inform guidelines to foster the Geodesign diffusion and its proactive implementation as a mean to address current pitfalls in urban and regional planning SEA.

3.1 THE ITALIAN PLANNING SYSTEM

The structure of the Italian planning system dates back to the 1940s. Since then it has evolved to the present day through slow steps of innovation. Since 1942 the Italian National Planning Law n. 1150 promotes a top-down three tiers hierarchical system which basically includes territorial plans, local land-use masterplans (usually at the municipal level), and sub-municipal implementation sectorial plans. Initially the system was intended as a tool to deal with strong urbanization pressure in the first half of the XX century and urban reconstructions in the aftermath of World War II. After few decades, in a period of considerable residential expansion, the issue of urban quality standard came to stage as a consequence of the need to equip cities of modern social services and infrastructure facilities. Therefore land-use plan design priorities became related the need to ensure the proper balance between housing and services for residents. Law n. 765/1967 and the Ministerial Decree n. 1444/68 addressed these issues introducing standards for land-use design, as well as physical parameters for urban development. The zoning instrument was also somehow institutionalized by the same law, encoding in a standard classification future development land-use categories. The attention paid to such services as education, cult, health, as well as recreation, parking and green areas contribute to shift the scope of planning from quantity to quality and community well-being. While the latter can be considered one of the perspectives of Geodesign, the solution proposed at that time (i.e. the introduction of minimum quantity standards) can be nowadays considered an unfledged approach to be further innovated.

New breath of innovation was brought in the Italian planning system in 1985, when Law n. 431 introduced the contemporary conception of territory as a unitary system and finite resource storage to be preserved. Modern landscape plans were introduced bringing to stage the environmental planning approach. This is the time in Italy when first environmental services started to become mandatorily an object of analysis. Territory started to be considered as an environmental, economic and socio-cultural system, the savvy management and development of which had to be based sound knowledge and informed decision-making. More recently, with Code of Cultural Heritage and Landscape n. 42/2004 the planning model undergoes an important qualitative evolution towards a slight different concept of landscape as brought by the European Landscape Convention. Environmental or landscape compatibility assessment became a significant element of contemporary urban and regional plans. Environmental systems carrying capacity is becoming the starting points of contemporary territorial planning, where the planner is a coordinator of multidisciplinary pool of experts ranging from architecture to engineering, from history and archaeology, from geology to hydraulics, from sociology to economy, to which Geodesign add a new figure of spatial information specialists.

The evolution of the spatial planning approaches brought by the Italian legislation briefly outlined here, is intended not to be exhaustive, rather it is proposed as a general background framework for the analyses of the Geodesign key principles found in selected Italian regional case studies, as discusses in the next section.

4 GEODESIGN PRINCIPLES IN ITALIAN REGIONAL PLANNING REGULATIONS

In this section a more detailed discussion of the relationships between the legislation framework and the GDF models are given. At the end of the section a matrix is proposed synthesising the results.

The first stage of the GDF is the Representation Model (RM), whose purpose is to understand how the geographic study area should be described. The description should be as complete as possible in space and time. There is not a predefined set of data to analyse, but it is important to select those needed in relation to the case study at hand, and to organize them in the geographic space (Steinitz, ibidem).

The RP is perhaps the one among the other GDF models which is never missing in a planning and design study. However looking back to the first Italian Law 1150/42 and following modification and integrations, its content has deeply evolved along time. In the last decade, regulations on Strategic Environmental Assessment (i.e. Directive 2001/42/EC) started to affect the content of urban and regional plan requiring to include in the SEA environmental report a complete description not only of the environmental, economic and social data, necessary to represent the local Environmental Framework, but also all the other existing local regulations and projects affecting territorial context (or, the Normative Framework). A correct Geodesign implementation would imply to treat all these relevant information spatially: this is a requirement that is not necessarily always properly addressed in the practice.

Also there is not a singular methodology to collect and display data, but it is recommended to choose visualisation methods and spatial scale of representation which provides the variation of different ways to look at the territorial context (Steinitz, ibidem). In the first iteration the RM should help to define boundaries of the study area, its geographies, and list existing sources of (digital) information and services. The later part is something that has currently started to be addressed by spatial planning law thanks to the recent development in RSDIs, as demonstrated by the examples discussed in this section. In the second iteration, however it should be decided in the light of the input need of all the GDF models, exactly what data, what scale and accuracy, what processing services are required. Until recently, the representation of spatial data is more generally concerned by the recent European legislation on the development of the INfratructure for Spatial InfoRmation in Europe (i.e. INSPIRE, Directive 2007/2/EC). According to INSPIRE interoperability principles, public administration at all level in the Member States should give public online access to 34 spatial data themes according to common specifications. Moreover, many planning regulations and spatial plans require using public authorities' data resources in plan-making, thus affecting the format the representation model with important implications for the planning and design processes. Moreover, many planning regulations and spatial plans require using public authorities' data resources in plan-making, thus affecting the format of the representation model with important implications for the planning and design processes. This is the most challenging part of the process for data in RSDI are not necessarily created for planning purposes and their reliability should be carefully evaluated. One important implication is that SDI implementing rules, which define common data models, are eventually affecting the content and format of the planning knowledge in a European wide process. This issue which started to be addressed by Plan4All (http://www.plan4all.eu) an eContentplus EU project carried on by a consortium of 24 partners from 15 European countries, aiming at harmonizing spatial planning data and related metadata according to the INSPIRE principles, and it should be further analysed in order to understand the technical implications for the planning practice. Eventually, in the third iteration GDF data are collected and integrated for use. The latter seems to be an issue successfully addressed as current RSDI download and invoke services usually allow online open data access.

Looking at the regional level in Italy, the Lombardy Regional Territorial Government Law n. 12/2005 (Lombardy LR12/2005) in Article 3 institutes the Territorial Information System (TIS) as a new tool to coordinate local information. The TIS or the Lombardy regional SDI (L-RSDI) integrates thematic datasets from multiple sources, including public authorities at all levels and the scientific community. Public authorities also provide approved plans and projects in digital form updating dynamically the L-RSDI knowledge base. In Lombardy LR12/2005, Article 8 specifies the municipal territorial government plan (PGT) documents content: the territorial knowledge framework of the municipality should include historical development of settlements, geological, hydrogeological and seismic characteristics, mobility infrastructures, risk vulnerability sites, natural habitat sites, the agricultural landscape structure, and urban fabric, among other spatial data themes. This way both the environmental and the normative frameworks are constantly updated and made available. With the possible limitations explained earlier in this section, the L-RSDI allows to acquire relevant data to be used in the GDF iterations for the representation model.

Also in Tuscany, thanks to Article 28 of the Regional Territorial Government Law n. 1/2005 (Tuscany RL1/2005), the regional government together with the provinces and the municipalities are responsible for the management of the Regional Geographic Information System (RGIS) in order to integrate the geographical knowledge, to organize, update, advertise it and make it available to all the stakeholders involved in the planning process. The Tuscany RGIS also features a geoportal which give access to download services. In the same law article the RGIS is also clearly defined as a key reference point for the construction of the knowledge framework useful in developing decision-support tools for spatial planning and environmental impact assessment.

According to Tuscany RL1/2005, Article 29 moreover, the RGIS collects information from the public authorities and the scientific community, which includes the following themes: topography and geology, orthophotos, satellite images and historical maps, thematic databases on the state of the local resources as well as the local knowledge as resulting from the local planning tools. The Regional Government is responsible for regulating the information management process, the technical specifications and the standards to be adopted for preparation and diffusion of geographic data, affecting the first and especially the second iteration of the RM.

In Sardinia conversely, the Regional Spatial Planning Law n. 45/1989 (Sardinia RL45/1989), does not refer either to any specific Regional SDI, nor it recommends any specific data management technology unlike the former. This is not surprisingly for dating back to 1989 this law could have barely foresaw what would have been the evolution of the paper map based information system available at that time. Nevertheless integrations to Article 19, specifies that a landscape and environmental compatibility study attached to Local Land-Use Plan (LLUP) should contain the municipality cognitive framework with indication of geologic, geomorphologic, hydrologic, landscape and historic contents, and settlement and infrastructure transformations, somehow affecting the implementation of the RM and the overall GDF. Nevertheless, in Sardinia, recent SEA-LLUP official guidelines, while defining the Environmental Report contents (ER), requires a description of the current status (i.e. do- nothing alternative) of 11 given environmental components (e.g. air, water, waste, soil, flora and fauna biodiversity, landscape, settlement system, economic system, transport, energy and noise) through specific summary data sheets which lists the information to be included, the indicators to be developed and the maps to be produced. The same indicators should be compiled at a later stage (i.e. in the impact model) for design alternatives. This way, the SEA-LLUP guideline affects both the RM and the IM.

The second stage of the GDF is the Process Model (PM), whose purpose is to understand how the study area operates by identifying ongoing physical, ecological, human and geographical processes and relationships among them. In the second iteration it should be defined what analytical, simulation or forecast models should be used to describe selected environmental or anthropic processes, and how their results should be visualized and shared. To the latter respects, it is not easy to find clear links to specific steps of the PM within the body of legislation under analysis, possibly because no guidance was found on the methodology to be adopted for the plan preparation, of which this model is an essential part according to the GDF. However, it is possible to find some references to first the iteration in terms of which processes should be concerned in the analyses.

Tuscany LR1/2005 Article 33 specifies that the Regional Landscape Framework Plan should contain the analysis of territorial the transformation dynamics through the identification of risk and vulnerability factors, whereas in the Sardinian LR45/1989 the socio-demographic analyses and forecasts and consequently the housing requirements, represent a mandatory step, as stated in Article 19, in LLUP plan-making.

With regards to SEA regulations, both in Tuscany (i.e. RL10/2010) and in Sardinia (i.e. Reg. Dept. Env. Act n. 33/34 -2012) it is specified that ER should contain information about the likely evolution of the environment without the plan implementation. No reference is given to any method or tools to achieve comply with this requirement, which is actually transposed from Annex I of Directive 2001/42/EC which sets out the contents of the ER.

The third stage of GDF is the Evaluation Model (EM), which concerns such questions as if the current study area is working well, why or why not, what are the main problems and possible opportunities. This is a knowledge step in which it is important for decision-makers and stakeholders to choose suitable evaluation method (e.g. scientifically or judgement based), criteria related to the geographical context and to assign them weights and a values. This model strongly influences the decision-making process because determines areas attractiveness, vulnerabilities and risks, and as a consequence those who need to be changed or to be preserved.

In Lombardy LR12/2005, Article 8, it is required for the Municipal Territorial Government Plan to identify and portray in a suitable representation scale several functional suitabilities with regards to such objectives as environmental, landscape, historic, geologic and ecologic preservation, or requalification, indicating also the possible actions and their purposes. In Tuscany LR1/2005, Article 53 states that the municipal masterplan should indicate the functional and territorial systems and sub-systems which define the territorial identity structures, the structural values as defined in Article 4, the criteria for the use of resources, the instructions for landscape safeguard and for environmental and cultural heritage protection, as well as significant public interest areas and properties. Article 33 moreover specifies that Regional Landscape Framework Plan contains analysis of relationships among historic, natural and aesthetic characteristics and as a consequence the definition of landscape value to be considered as attitude or vocation to change. In Sardinian LR45/1989, Article 19 specifies that the municipal land use masterplan should define the areas which need special protection and safeguard rules as well as the areas which need existent urban rehabilitation.

Thus, in all cases territorial systems or sub-systems to be evaluated somehow are pre-determined by the regional planning legislations. As in the case of the PM, also for the EM methods and tools are not mentioned. Nevertheless they could be concerned by technical guidelines complementing regulations. In fact, in Sardinia the SEA-LLUP official regional guidelines, in order to represent in a synthetic manner the results of the environmental analysis, suggest the application of the SWOT analysis, which allows the identification of Strengths and Weaknesses of an area and as a consequence Opportunities and Threats. This analysis aims to detect possible environmental critical issues that may be affected by the plan, and to highlight the vocations of the territory.

The fourth stage of GDF is the *Change Model* (CM), whose purpose is to understand how the geographic study area might be altered. This is the first stage of concrete design as traditionally intended in which strategic and physical development policies are proposed and simulated. The typical products of change model are data that will be used to represent future possible conditions (i.e. the zoning map in a land-use plan). The representations of chosen scenarios are then input for the next steps of GDF and could be used during communication and participatory phases.

In Article 8 of Lombardy LR12/2005 it is specified that the Municipal Territorial Government Plan identifies strategic development goals according to higher level territorial policies and then it defines quantitative development goals considering the importance of territory requalification, the soil consumption reduction, the rational use of environmental and the savvy use of energy resources. Tuscany LR1/2005 in Article 53 claims that municipal masterplan sketches territorial development strategies defining territory governance orientation and in the Article 11 on integrated assessment, it refers to possible alternative plan solutions. In the Sardinian SEA-LLUP guidelines it is specified that the SEA process should support the design of one or more possible alternatives for the development of the municipal area, also including participatory consultation in this stage. Likewise, Tuscany RL10/2010 in Article 24 describes the ER contents referring to the identification and description of the sustainable plan alternatives implementing the system of the objective. In Lombardy a regional Resolution on the SEA of PGTs n.13071/2010 refers to reasonable alternatives to be designed and documented during ER elaboration.

The fifth stage of GDF is the *Impact Model* (IM), whose purpose is to understand which effects the changes might cause in the whole territorial context. There is a broad set of phenomena to be considered, and their choice depends on the expected changes and on the local context to be analysed. Each phenomena being investigated need a different impact model which focuses on a specific potential consequence that will have to be evaluated: economic and demographic impacts, environmental impacts related to such parameters as water and air pollution, energy use, biodiversity, public safety, noise and so on. Different impacts are often linked to each other in networks and they need to be combined into geographic context and summarized to identify their interactions. The study result of this step of GDF is generally a set of thematic maps showing qualitative, quantitative and spatial differences between the state of the place before and after plan choices. Impact matrixes, check-lists and network models, as well as complex systems of indicators are also used.

In order to promote resources preservation and sustainability development, Article 4 of Lombardy LR12/2005 requires the SEA of all territorial and urban plans since the early stage of decision-making processes toward the implementation of proposed actions, as prescribed from Directive 2001/42/EC. The environmental impact study should supply the identification of potential impacts resulting from alternative plan choices, verify if they are beneficial or harmful and foresee mitigation measures if needed. Article 8, which specifies content of the local plans documents, remarks the necessity to demonstrate the compatibility of intervention policies with public administration economic resources and with the effects generated in the affected territory. The main regulation never refers to the way of carrying out the analysis and does not specify which models are needed to assess and compare impacts deriving from potential changes.

Tuscany_LR1/2005 on Article 11 introduces the Integrated Assessment as a mean for evaluation of territorial, environmental, social, economic and human health effects before planning tool adoption since the first stage of the plan preparation. Integrated assessment should include compatibility assessment in relation to the use essential territorial resources as defined in Article 3 (i.e. air, water, soil, natural ecosystems, cities, landscapes, cultural heritage and infrastructural systems).

Sardinia LR45/1989 clearly states in its first article that planning should guarantee territorial resources protection and environmental protection, and artistic and cultural heritage safeguard, and on the integration of Article 19 refers to the SEA Directive specifying that landscape and environmental compatibility studies should include the environmental assessment of local plans. More recently, Sardinian SEA-LLUP guidelines specify that the assessment of the effects that the implementation of the plan on the environment should be carried out for all the design alternatives. The guidelines also suggest the usage of such methods as impact matrixes and overlay mapping. While matrixes are commonly used in the practices, complex overlay or spatial multi-criteria methods are not yet found often in ERs. These kind of analyses proposed by the GDF IM is among the contributions that SEA should bring to innovate urban and regional planning, perhaps to more consolidated in the practice.

The sixth stage of GDF is the *Decision Model* (DM), whose purpose is to understand how the study area should be changed through the identification of the best balanced possible alternative among those designed during the other steps of the Geodesign study. The DM also entails a series of activities which are relevant for the SEA of regional and urban plan for it should eventually demonstrates that the final choice is preferable in the light of the complex system of objective at stake. In Sardinian SEA-LLUP Guidelines it is generically specified that evaluation of the plan alternatives aims at identifying the one that, while ensuring the achievement of development objectives, determines the lower environmental impact.

Summarising the result of the analyses the matrix in table 1 shows in shades of grey (i.e. the darker the stronger) the relationships between the Geodesign framework models and the analysed regulations.

5 CONCLUSIONS

Most recent regional territorial government laws in Lombardy and Tuscany carefully take into account the role of the regional SDI as a base platform for knowledge management in design, planning and decision-making. Together with the ongoing process of transposition of the INSPIRE Directive this trend is likely to affect substantially the implementation of representation models in urban and regional planning. In Sardinia a similar trend is addressed by the new Regional Landscape Plan which sets directions for local land use planning including technical rules for plan content and portrayal. Altogether this trend may facilitate the diffusion of innovative Geodesign approaches also in other stages of the planning process.

	Representation Model			**Process Model**			**Evaluation Model**		
	FIRST ITERATION	SECOND ITERATION	THIRD ITERATION	FIRST ITERATION	SECOND ITERATION	THIRD ITERATION	FIRST ITERATION	SECOND ITERATION	THIRD ITERATION
LR n.12/2005 Lombardy									
LR n.1/2005 Tuscany									
LR n.45/1989 Sardinia									
SEA-LLUP guidelines (Sardinia)									

	Change model			**Impact model**			**Decision model**		
	FIRST ITERATION	SECOND ITERATION	THIRD ITERATION	FIRST ITERATION	SECOND ITERATION	THIRD ITERATION	FIRST ITERATION	SECOND ITERATION	THIRD ITERATION
LR n.12/2005 Lombardy									
LR n.1/2005 Tuscany									
LR n.45/1989 Sardinia									
SEA-LLUP guidelines (Sardinia)									

Tab.1 Relationships between the Steinitz' (2012) Geodesign Framework Models and selected national and regional legislation in Italy

With regards to the other models to be implemented according to a Geodesign approach, so far less connections are found between planning regulations and applied methods, which should be defined in the second iteration of the GDF.

As noted elsewhere by Campagna (2014) the second iteration is strictly related to metaplanning, that is the activity of shaping the planning process in an operational workflow of activities. This is something missing in the planning legislation although it may have relevance to the process assessment as indicated by SEA regulations and good practices.

This is an issue which should be subject of further inquiry. More references are found however to the first GDF interaction, where the scope of the Geodesign study is defined, and to the third which define the practical implementation of the study up to the output, whose format is often partially pre-defined by law.

In synthesis the early results of this study highlight some of the gaps between underlying principles which frame by law the planning practice and actual design methods and planning outcomes. Whether this gap is deliberately kept or it may derive by a lack of methodological skills should be further investigated. Nevertheless, given the current Italian normative framework, a Geodesign approach may possibly help to solve critical issues for a proactive implantation of the principle brought by current regulations.

This study can be considered as a preliminary analysis which aims at mapping the relationships between methodological approaches within the normative framework. It can represent an early base for more systematic legislation analyses in order to find space for methodological innovation on top of developing territorial government platforms.

A clearer understanding of these relationships by educators, public administrators and practitioners may contribute to set up operative guidelines and tools to better interpret the principles brought by regulations. The Geodesign approach may turn out to be a reliable methodological way to bridge the gap between urban and regional planning strategic environmental assessment, exploiting the valuable knowledge that growingly is being embedded within developing spatial information infrastructure.

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GEODESIGN FROM THEORY TO PRACTICE:

FROM METAPLANNING TO 2ND GENERATION OF PLANNING SUPPORT SYSTEMS

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ABSTRACT

This paper deals with the concept of Geodesign, a new approach to spatial planning and design which is grounded on extensive use of Geographic Information Science methods and tools. As a method Geodesign is intended to inform projects since their conceptualization, to analysis and diagnosis, to design of alternatives and impact simulation, and eventually the final choice. This approach appears particularly urgent and actual to many scholars from academia and practitioners from the industry and the planning practice for advances in GIScience nowadays offer unprecedented data and tools to manage territorial knowledge for decision-making support. The author argues research in Geodesign may contribute to solve major actual pitfalls in sustainable spatial planning: namely it may offer methods to help planners to inform sustainable design alternatives with environmental considerations and contextually assess their impacts; secondly, it may help to ensure more transparent, responsible, and accountable democratic decision-making processes. The argumentation is supported by the author recent research results with regards to the evolution from 1st generation Planning Support Systems (PSS), to metaplanning and 2nd generation PSS.

KEYWORDS

Geodesign, Metaplanning, Planning Support Systems, Strategic Environmental Assessment, Urban and Regional Planning.

1 INTRODUCTION

The role of the technical rationality in planning changes according to spatial and temporal contexts with the different political, administrative and socio-cultural settings which may occur. These conditions affect the role all actors– including the planner itself – have in the planning arena, the way they participate (Arnstein, 1969) and the way they affect the final decisions. Hence in practice, the influence of those decisions on the future territorial development patterns -informed or not by the technical rationality (Flyvbjerg, 1998)- varies accordingly. It is not always straightforward for the community, as well as for the stake-holders involved in the planning process, to understand the "why" and the "how" decisions are made. This may be considered a major issue when dealing with the sustainability of the development processes, for it involves such important dimensions as responsibility, accountability, transparency, and eventually democracy of decision-making. In fact, the concept of sustainability of development is a complex one for it entails, as expressed by the principles of the Rio Declaration (UNGA, 1992), many dimensions to be considered along with the development processes, which in turn should be democratic, environmentally savvy and based on informed decision-making. In Agenda 21 (1992) two of its 40 chapters are specifically dedicated to the role of the scientific and technology community in sustainability, and to the role of information in decision-making. These objectives found transposition in the European policies on environmental impact assessment. Strategic Environmental Assessment was introduced in Europe in 2001 by the Directive 2001/42/EC with the aim of providing high levels of protection of the environment and contributing to the integration of environmental considerations in plan-making, according to sustainable development principles. After a decade of its adoption the implementation of the SEA Directive is widespread in Europe. SEA can be defined as a structured, rigorous, participative, open and transparent environmental impact assessment based process, applied to plans and programs (Fisher, 2007). Nevertheless, concern is often raised about its actual efficacy with regard to its real capacity to inform decision-making in the regional or local land-use planning process (Sheate, 2004; Fisher, 2010).

Hence, research in sustainable spatial planning should address two major issues, which are still poorly understood and not adequately tackled in the practice: more reliable methods are needed in order i) to inform the design of the territorial development by environmental considerations, and ii) to govern the development process so that it may be clear the how and the why decisions are made, by whom and on behalf of whom. Again, these appear such relevant issues that if not properly addressed may undermine any endeavour towards sustainability in a planning process.

In the light of the above assumptions, this paper reports current results of an ongoing research project on the impact of Strategic Environmental Assessment and Spatial Data Infrastructure policies in urban and regional planning. The project case study focuses on Sardinia (IT), where the actual planning system is nowadays characterized by a Regional Landscape Plan informing top-down the regional spatial governance, and by local land-use plans which should enact the RLP strategies in the Sardinian municipalities. The implementation of this scheme, which finds similar cases in other regions in Italy and Europe, is currently affected by the implementation of both the Directive 2001/42/EC on Strategic Environmental Assessment, which introduces impact assessment procedures for plans and programs- including regional, urban and sector planning-, and the Directive 2007/02/EC, which introduces the INfrastructure for SPatial InfoRmation in Europe (INSPIRE). While the first requires methodological innovation in the plan-making methods and processes in order to achieve more sustainable, informed and democratic decision-making, the second is starting to offer the Information Communication Technology (ICT) tools (i.e. interoperable digital spatial data and services) for easing knowledge building, collaboration among stakeholders, and decision-making support in urban and regional planning. These two factors together are starting to affect the way plans are made, their contents, their format, generating the urgent need -as well as the unprecedented opportunity- for the development and the diffusion of integrated planning support systems (Harris, 1989; Brail and Klosterman, 2001; Campagna, 2004; Geertman and Stillwell, 2009).

Hence the relevance of the question on how to fill the gap between Planning Support System (PSS) research and real-life planning practices. The tentative answer given by the first research results presented in this contribution is twofold: on the one hand, much work is still needed to adapt existing software (i.e. 1st generation PSS) to local contexts easing their adoption by local planners, possibly serving customized functions by Regional SDI added-value services; on the other hand, innovative models for PSS should be conceived, implemented and tested in order to address some of the acknowledged pitfalls of 1st generation PSS, including among other their still existing limits of adaptability to different planning models and contexts. While in fact, 1st generation PSSs usually rely on off-the-shelf software or on custom software ad-hoc developed for given processes, the concept of 2nd generation PSS can be though as an enabling platform which is intended to ease the governing or the management of the planning process including the orchestrated supply of the required (geo-) Information and Communication Technology (ICT) tools along the various steps of the planning process workflow. Thus, it should be noted, that while research on 1st generation PSS entails a more applied research approach in engineering, the formalization of the novel concept of metaplanning and 2nd generation PSS pivots around more theoretical social and management science issues in spatial planning.

With the above premises in Section 2, the concept of Geodesign is proposed as an innovative approach to urban and regional planning which, it is argued, may help to inform design by geography. The application of this approach is discussed in Section 2.1 with reference to the implementation of a pilot 1st generation Planning Support System for the the Strategic Environmental Assessment (SEA) of Local Land Use Planning (LLUP) in Sardinia. In Section 3, the author proposes the concept of metaplanning as a method to manage the planning process aiming at ensuring its transparency, accountability, and traceability, and arguing that it may eventually support collaboration among the planning actors and inform the design of and the seamless implementation of 2nd generation Planning Support Systems. In the last section the author draws some conclusions on the opportunity offered by metaplanning to contribute to advancement in Geodesign research and sustainable planning practices.

2 THE EMERGING GEODESIGN PARADIGM AND 1ST GENERATION PSS

The term Geodesign has since recently become popular among spatial planning and Geographic Information Science scholars as an approach to planning and design, which is deeply rooted in geographic analysis to inform collaborative decision-making. This emerging trans-disciplinary debate concerns both the definition and the application of the concept of Geodesign (Steinitz, 2012). Geodesign can be defined as an integrated process informed by environmental sustainability appraisal which includes project conceptualization, analysis, projection and forecasting, diagnosis, alternative design, impact simulation and assessment, and which involves a number of technical, political and social actors in collaborative decision-making. The innovation in Geodesign, compared to older approaches in environmental planning and landscape architecture, falls rather on the extensive use of digital spatial data, processing, and communication resources.

As a matter of facts nowadays, the Information Society reached a mature age, and we face unprecedented wealth in terms of digital (spatial) data sources. The concept of Digital Earth (Craglia et Al., 2012) is slowly shaping into reality, and both authoritative and volunteered geographic information resources are available to support analysis and decision-making. Nevertheless in spatial planning, professionals and decision-makers still lag-behind in the digital uptake in the practice, and in properly taking advantage of developing Spatial Data Infrastructures. Hence, making the Geodesign concept operational may be still considered a challenging task for many professionals and practitioners. Nevertheless, this should be not be considered a minor issue for urban and regional planning legislation, as well as environmental assessment regulations and good practices, are making digital spatial data analysis and representation the mandatory working-space for spatial planners. In Italy, as a matter of facts, new regional spatial planning laws in Lombardy and Tuscany, as well as the Regional Landscape Plan in Sardinia, require to develop local land use plans relying on the respective regional Spatial Data Infrastructures data and services, and to represent the final plan in digital format. In these conditions while traditional plan-making method and tools are outdated and lack in competitiveness, the adoption of new media and tools without properly exploiting their potential would be a major missed opportunity for innovation with imponderable detriments to sustainability of development choices.

Geodesign on the other hand may constitute a promising approach in order to address current open issues in SEA, possibly bringing the invoked innovation in urban and regional planning. Steinitz (2012) recently proposed an integrated Geodesign framework (GDF) for the implementation of the approach in urban and regional planning and design. The GDF consists of six types of models the implementation of which is carried on iteratively. The representation models answer questions about how the environmental system, or the landscape, should be described. Then the process and the evaluation models explain how the system is evolving and what opportunities and threats can be devised. Once the base knowledge is created it may be used to inform the design of possible solutions or alternatives with the change models, whose outputs are then assessed through impact models and eventually chosen with the decision models. This methodological framework may be implemented in many ways. Among the possible interpretations, in the next paragraph ongoing research results are synthesised with regards to the implementation of a Geodesign approach in the pilot Planning Support System for the SEA of LLUP in Sardinia (further details of which are out of the scope of this paper, but are extensively documented in: Campagna and Matta, 2014).

2.1 THE SEA-LLUP 1ST GENERATION PLANNING SUPPORT SYSTEMS

The core of the contemporary regional planning system in Sardinia is characterized by a Regional Landscape Plan (RLP) adopted for the first time in 2006. The RLP defines protection rules for landscape safeguard and coordinates local development, and municipal land-use plans (LLUP), which in turn implement the RLP policies at the local level. Both the RLP and the LLUPs should undergo Strategic Environmental Assessment along their preparation. The RLP integrates the system of rules set by the regional planning regulations including well defined requirements with regards to the contents and formats of the planning information. Likewise, the guidelines issued by the Regional Government for the preparation of the SEA documents (i.e. the environmental report) also specify which information and indicators should be included, creating a framework for the knowledge base to be used for decision-making.

The spatial governance of the Sardinian planning system is supported since the early 2000s by the Regional Government Geographic Information System. From the data and technology perspectives, the regional GIS has recently evolved towards an advanced Regional SDI (Craglia and Campagna, 2009) for it nowadays provides all the main SDI components required by Directive 2007/02/EC concerning the creation of the Infrastructure for Spatial InfoRmation in Europe (INSPIRE). The Sardinian regional geoportal offers a catalogue service through which data can be searched and accessed via download or network services. The

Sardinian RSDI currently offers over 300 data layers, including vector, orthophotos and satellite images and high resolution Digital Elevation/Surface Models. Hence, the RSDI offers an unprecedented wealth of spatial information which can be used to support the application of Geodesign to address pitfalls in the SEA of the LLUPs.

In order to test the potential of the SRSDI as knowledge base for Geodesign, a Planning Support System prototype for SEA-LLUP has been implemented (Campagna and Matta, 2014). The main features of the PSS include a module which implements land-suitability analyses (Malczewski, 2004) to support the design of planning scenarios or alternatives. The design is also supported by a sketch planning (Harris, 1989) interface which thanks to a digital pen supports the planner real-time interaction with the design alternatives. Moreover, the system implements a spatial DPSIR model for real-time impact assessment. The indicator framework is calculated run-time and the results presented in a dynamic dash-board supporting collaboration. Once decisions are made the environmental report may be populated automatically by all the relevant information using predefined templates.

While the first functionalities are intended to support real-time planning collaboration and interaction among stakeholders, the latter one eases the creation of the output reducing the burden of editing the environmental report. The system has been implemented customizing commercial software to the Sardinian SEA-LLUP settings. However its use arguably can be generalized to other European regions. In fact the indicator framework implemented for Sardinia SEAS-LLUP relies on the use of the spatial data sources of the Sardinian RSDI, which in turn feature close relationships with the INSPIRE spatial data themes.

Current results include the real-time calculation of a number of indicators related to development options expressed in terms of land-use patterns changes and infrastructure network design. Further indicators are under study to enrich the spatial DPSIR model complexity towards the development of a spatial version of enhanced DPSIR (Niemeijer and de Groot, 2008).

This kind of approach to 1st generation PSS design evolves along a path which was paved along two decades of research work; it seems it may lead, as a reasonably achievable operational target, to contribute in the short-medium term to bridge the gaps among analysis, design, impact assessment, choice, and reporting, this way implementing Geodesign in the Strategic Environmental Assessment of urban and regional planning. However, as argued in the reminder of this paper, for the medium-long term, research in planning (support system) and Geodesign may offer less paved research alleys wherein theoretical and methodology challenges would be more related to the social and business management sciences perspective of the planning process rather than to more practice oriented land engineering.

3 METAPLANNING AND 2ND GENERATION PSS

The evolution of contemporary spatial governance makes urban and regional planning complex processes - involving actors, activities, resources, objectives, outputs- which are often difficult to manage in a logical, transparent and accountable manner. As a matter of facts a new figure of planner is emerging as a 'process manager' (Zanon, 2014) whose role is the coordination of interacting actors in complex workflows of activities.

In real-world spatial planning practices (i.e. Regional Planning or Local Land Use Planning) often metaplanning, as something which is usually not explicitly required by law, is disregarded. In such cases taming complex multi-actor planning processes and procedures may result confusing and the outcomes uncontrollable. While on the one hand lack of common understanding among the actors may easily arise, implying difficulties in collaboration, on the other hand understanding how, why, when, by whom planning decisions are made may results blurred both to internal and external stakeholders and observers. The latter should be not considered a minor pitfall as both propositions from advances in planning theory (i.e. Innes' communicative planning, in Khakee, 1998, p. 370) as well as binding regulations on Strategic Environmental Assessment (SEA, Directive 2001/42/EC) –the environmental impact assessment of plans and programmes- require in plan-making not only the evaluation, explanation and documentation of the product (i.e. the final plan) but also of the process through which the plan was made. However, what SEA regulations and good practice guidelines usually suggest is an in-itinere or ex-post evaluation of some specific part of the SEA-planning process (i.e. degree of public participation in consultation or reliability of data sources), and an ex-ante metaplanning approach is often ignored. To address this issue in the next section the concept of metaplanning is proposed by the author.

3.1 METAPLANNING PRINCIPLES

Metaplanning can be defined as the design of the planning process. Metaplanning consists of the activities of specifying actors, activities, methods, tools, inputs and outputs, workflows or in other words the ex-ante and in-itinere adaptive design of planning the process. The objectives of metaplanning are both the improvement of the process and of its outcomes as well as its management and implementation. Moreover, as argued by the author in the reminder of this paper, metaplanning eases the design and implementation of the integrated planning supporting (digital) technologies.

It should be noted that close relationships with the metaplanning concept can be found as central to the Steinitz's Geodesign framework (GDF; Steinitz, ibidem) where the planner (or the Geodesign team) chooses and clearly defines the methods for the study according to a decision-driven approach (i.e. the second iteration in the GDF), before the resulting workflow is actually implemented (i.e. the third iteration).

The operational implementation of the concept of metaplanning should be achieved through the detailed description of the planning process. Several attempts have been proposed by scholars to formalise the description of the planning processes for a variety of purposes, however these results appears to have affected neither current planning practices nor the Planning Support System design (Geertman and Stillwell, 2009). As a matter of facts, limitations in Planning Support Systems diffusion may be addressed to lack of flexibility, thus of adaptability to contextual settings of the planning processes.

To address this issue a possible approach is to rely on recent advances in Business Process Management (BPM) (Weske, 2012). Process-orientation has gained big momentum in the last decade, and BPM reliable techniques and tools have been developed aiming at two main objectives: improving process management and easing information system development. BPM found extensive application in manufacture and service industries where goods and services production processes are cyclically run and improved. Introducing BPM in the production life-cycle requires effort, but it is usually acknowledged that the costs then pay off in the long run as the number of process instances grows.

The author argues in this paper that PSS design should also be process-driven, rather than technology-driven, and since metaplanning concerns the design and formalisation of the actual planning process, metaplanning should also inform the design of the information systems for planning support. To address this challenge, Business Process Management methods and tools have been applied by the author to implement the metaplanning concept in the urban and regional planning, and Strategic Environmental Assessment domain, claiming that metaplanning may both improve the process and ease customised PSS development accordingly. The latter results entail the concept of 2nd generation PSS, which can be thus defined as an enabling platform for process-oriented PSS design and implementation. The proof-of-concept of 2nd generation PSS, with the technical implementation details – whose discussion is out of scope in this paper-were recently documented elsewhere by Campagna et Al. (2014). Rather, in the next section, issues concerning the BPM application to metaplanning are discussed outlining a future research agenda.

3.2 METAPLANNING IN PRACTICE: A BPM APPROACH

BPM includes concepts, methods and techniques to support the design and analysis as well as the administration, the configuration, the enactment of business processes (Weske, ibidem). Hence, two are the main objectives of BPM: on the one hand BPM should support the improvement of a process (i.e. business perspective: design and analysis), while on the other hand it should ease the implementation of the supporting information system (i.e. IT perspective: configuration and enactment).

The last decade faced the diffusion of a growing number of Business Process Management Systems (BPMS) which enact a business process on the base of an explicit process model representation. A Business Process Model (BPm) is a set of activity models and execution constraints among them. From this perspective, urban and regional planning processes can be considered as business processes and Planning Process Models (PPM) can be drawn for a descriptive (i.e. as-is) or prescriptive (i.e. to-be) purposes in metaplanning. In planning theory and practice several languages have been used to describe planning processes (Campagna, 2013) ranging from verbal description, such as articles in planning regulations, to graphical notations, such as workflow diagrams in planning handbook. However, most of the latter lacks semantic richness so that planning process models cannot be used to administrate or enact process instances.

In the last decade, Business Process Model and Notation (BPMN) has been developed and maintained by the Object Management Group as a standard graphical notation for representing business processes in form of diagrams. The rich semantic of this language allows representing actors (i.e. pool and lanes) and activities (i.e. tasks or sub-process) and a variety of executions constraints. Tasks can be manual, automatic or mixed, representing diverse situations of real world processes: automatic mixed tasks are those which are supported by the execution of distributed data (e.g. standard Web Feature Services, or WFS) or processing services (e.g. standard Web Processing Services, or WPS). As an example the PPMs in Figure 1-3 show how BPMN can be used to design a planning process with iterative shifts from high level general models to low level detailed description of each sub-part. For the sake of the example, the GDF (Steinitz, ibidem) was considered as reference process.

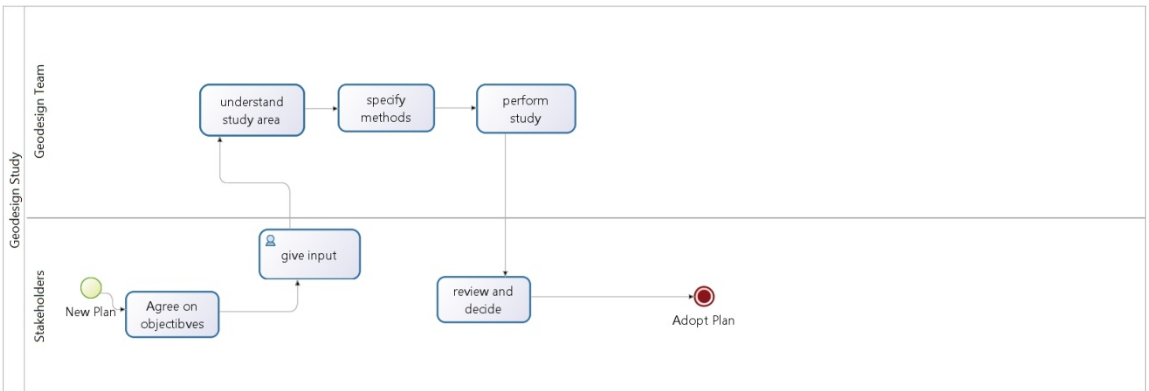

Fig. 1 High level BPMN Planning Process Model of the GDF

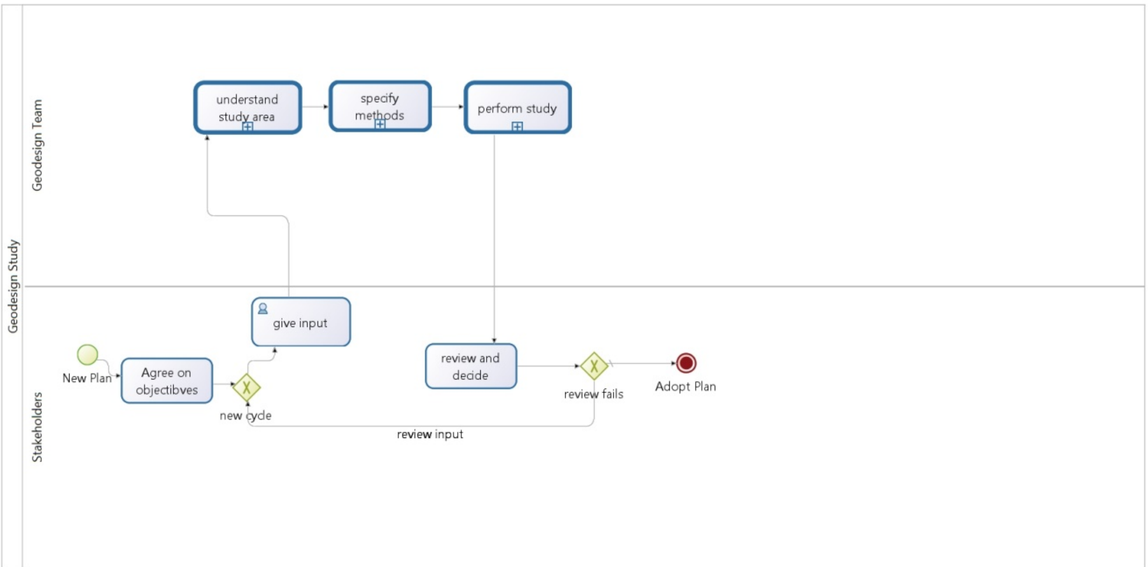

Fig. 2 High level BPMN Planning Process Model of the GDF with cycles

In Figure 1 a high level model of the Steinitz's Geodesign Framework (Steinitz, 2012, p.28) is given. However the simple model in Figure 1 shows a linear process, while in reality the process may develop along several cycles. Thus, the PPM in Figure 2 relying on the BPMN rich semantics shows that after the specialists of the Geodesign Team (represented in the horizontal upper lane of the diagram pool) complete their work and send the outcomes to the stakeholders, the latter may accept or not; in the latter case a new cycle is activated and the loop continues until the consensus is reached on the design products. Moreover, the three (macro) activities (i.e. the three GDF Iterations) performed by the Geodesign Team are in facts complex processes themselves. The three GDF Iterations may be interpreted respectively as planning process scoping, metaplanning, and implementation. BPMN support the modelling of sub-process of complex activities: in Figure 3 the main steps of the third GDF Iteration are represented, each of which in turn may be expressed as nested sub-process.

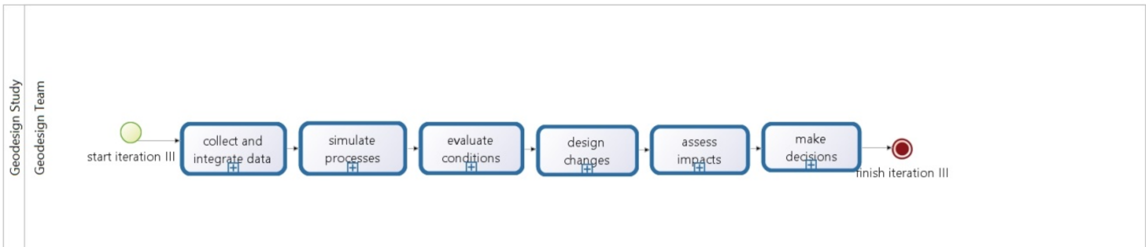

Fig. 3 High Level BPMN Planning Process Model of the III Iteration of the GDF

According to the Planning Process Modelling approach presented in the previous examples, models representing SEA and LLLUP process, as defined by local regulations and guidelines in Sardinia were developed in this project for simulation in order to analyse the process robustness and impacts, the discussion of which is out of scope in this paper. The next step in the research project will be to model case studies from the real practice in order to better analyse the implications of the use of as-is and to-be PPMs before testing BPM as metaplanning tool in real world settings.

Thanks to BPMN it is possible to model all the complexity of the processes down to the details of single tasks carried on by specific actors. BPMN diagrams can be understood from both humans and machines, becoming the core of business process life-cycle. In facts, many off-the-shelf BPMS feature a BPMN diagram editor for design and analysis, a repository where models are collected, and a process engine which orchestrates the integrated execution of services supporting a variety of tasks including high level applications (e.g. GIS) and/or (spatial) web services as recently demonstrated by Campagna et Al. (2014). Thus, after the modelling exercise is completed, the configuration phase in the BPMS enables to select and set-up all the necessary digital tools which will be then server to the relevant process actors run-time to implement Geodesign methods.

4 CONCLUSIONS

Nowadays, current advances in Spatial Data Infrastructures and other Volunteered sources of Geographic Information and sensor webs offer unprecedented wealth of knowledge which if properly treated may offer challenging opportunities for planners to represent and understand ongoing territorial processes, to inform design of possible changes, to assess their impacts and eventually support informed and responsible decision-making. In order to tackle the challenges put forward by the big data avalanche new methods and tools should be developed for a more effective achievement of environmentally, economically, and socially sound sustainable and democratic development processes. At the local level these objectives would be translated in more sustainable, effective and democratic decision-making in SEA of LLUP.

This paper proposes two research lanes to be carried on in parallel in order to achieve results in the short-medium and in the medium-long term, concerning respectively 1st and 2nd generation PSS .

In a nutshell, metaplanning may contribute to govern the complexity of the planning processes in the face of their diversity, eventually achieving more transparent, responsible and accountable plan-making processes. In fact, the accurate documentation of the planning process can help not only to document and communicate why and how choices are made, but also how environmental sustainability and strategic objectives were mediated in the change models. At the same time, metaplanning may support collaboration among the involved actors in the planning process thanks to a better shared understanding of roles, activities, and workflows. Last but not least, metaplanning would support the lean implementation of 2nd generation PSS.

Metaplanning and 2nd generation PSS research is still in its infancy, and several issues should be addressed in order to formalize an operational metaplanning body of knowledge to support its industrial deployment in the planning practice. Among other issues the research should concern cataloguing methods and tools to share Planning Process (or sub-process) Models to make common value of the modelling efforts. To this end, findings in 1st generation PSS research can contribute to populate repository of standard models of good practices to be shared among scholars and practitioners. Such a knowledge base would be of value not only to facilitate the sharing and promoting of innovative approaches and methods, but also to apply process models simulation and assessment tools to find and solve possible bottlenecks or lovelocks in current practices. Last, but not least, further research effort should be devoted to understand the more appropriate granularity in PPM: up to what scale processes should be decomposed in the modelling exercise in order to define possible architectural shifts from high level 1st PSS generation paradigm, towards service-oriented architecture. Still a long way to go, but definitely challenging.

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All images are originals developed by the author.

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THE ENERGY NETWORKS LANDSCAPE

IMPACTS ON RURAL LAND IN THE MOLISE REGION

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ABSTRACT

The paper concerns the study of the energy infrastructure that have the most impact on rural land. The analysis focuses on the systems for wind power and ground–mounted photovoltaic plants.

The case study is the Region of Molise, in Southern Italy. This Region is an emblematic case because it has a significant number of installations as seen in relationship with the whole national territory. The case becomes even more special with reference to local guidelines that have undergone successive formulations, precisely in relation to the installation in specific areas of the Region. The study analyzes current national and regional rules and it proposes a methodology to support Local Authorities especially in relation to the definition of landscape quality aims, that the new Regional Landscape Plan must provide.

KEYWORDS

Rural Land, Renewable Energy, Landscape, Environment

1 INTRODUCTION

The paper examines the panorama of installations in the Region in order to establish what the legislative framework is and what the actual state of these installations is. Following studies already carried out by our research group - including spatial analysis of knowledge of the land and its topography, its natural sites and its settlement systems, this paper describes an ongoing collaboration between our University of Molise, the Molise Region and the Regional Protection Heritage Office of Molise[1], for the verification of existing tools, analyzing in particular the restrictions resulting from the identification of areas of visual interest.

The first part of this paper describes the regional legislative situation and the context into which these power plants are inserted. This is followed by a description of the territorial analyses undertaken regarding the installation of such power plants, in particular in the Region's coastal zone.

2 THE REALITY OF THE MOLISE REGION

As regards the law, the paper mentions the national and regional standards that have evolved in recent years (Cialdea *et al.* 2010 a, b 2014). As is known, the production of electrical energy underwent a great change in the 90's: in fact, the two laws of 1991 opened a new scenario because from that time onwards the power production was no longer just the prerogative of ENEL (National Agency for Electricity), and the Regions were delegated to identify suitable areas within their territory for the exploitation of renewable energy sources. Moreover, the Act recognized the expropriation in the public interest of the land on which to establish installations for the production of renewable energy.

In 1999, to implement Directive 96/92/EC (common rules for the internal electricity market), the Legislative Decree no. 79/99 was issued which promotes the production of electricity from renewable sources. This obliged producers of energy from fossil fuels to introduce green energy into the electricity market by 2001 or, alternatively, as determined by the Ministerial Decree of 11 November 1999, to purchase of "green certificates". The reform of the Title V of the Italian Constitution (Constitutional Law no. 3/2001) assigned legislative power over energy production to the Regions[2].

Afterwards new Guidelines for the authorization of renewable energy, plants were implemented by the National Decree in 2010: they will be analyzed in this paper.

In 2006, the Molise Region adopted the Regional Environmental Energy Plan with the goal of optimizing and encouraging energy conservation, and enhancing green energy sources with particular attention to hydroelectric and wind power. The Plan highlights the potential of the Molise territory for the production of wind energy and suggests a target scenario for 2015 in which the installation of wind turbines exceeds 1,700 MW. In addition, the plan identifies areas within the river Biferno basin as sites of great interest for wind energy. The 2015 target scenario does not take into account the contribution of PV integrated into buildings, neither does it considered the construction of ground-mounted photovoltaic plants. The Plan also lays down

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1 In fact, in 2011, the l.a.co.s.t.a. Laboratory (Director prof. D. Cialdea) of the University of Molise was engaged for the realization of the "New Regional Landscape Plan of Molise", through an agreement with the Molise Region.

2 The Legislative Decree no. 387/2003, in transposition of the European Directive 2001/77/EC on the production of electricity from renewable sources, established the purpose of promotion of renewable energy sources. In particular art. 12 ordered that the works for the construction of plants powered by renewable energy sources are of public utility, urgent and subjected only to regional authorization in accordance with the Ministerial guidelines. In carrying out these guidelines, the Regions can indicate unsuitable areas and sites for the construction of specific types of plants.

the guidelines for the evaluation of projects and the impacts of wind farms to be implemented by future regional laws.

In 2008, the Molise Region issued its own regional law governing the installation of wind and photovoltaic plants in the area. This law and the subsequent guidelines, identified a number of areas unsuitable for the installation of wind and photovoltaic plants, in particular the areas of regional parks and nature reserves, the "zone 1" of national parks, areas of "protection and integrated conservation" of the Vast Area Landscape Environmental Plans, the SPAs (Special Protection Areas), SCI (Sites of Community Interest) and the area of the Tammaro Valley and the surrounding hills.

It must be stressed that this Law (Art. 2, paragraph 1) forbids the construction of wind farms even in the buffer zone of not less than 3 km from the perimeter of parks and archaeological areas, in the buffer zone of not less than 1 km from the urbanized perimeter, in the buffer zone of 500 meters from residential or rural houses, in the buffer zone of 200 meters from the perimeter boundary of the neighbouring municipalities, in the buffer zone of 5,000 linear meters from the coastline, in the buffer zone of 1 km from river shores, wetlands, lakes and dams.

These points of paragraph 1 of article 2 were declared illegal by the ruling n. 282/2009 of the Constitutional Court[3] because the areas deemed unsuitable were arbitrarily identified by the Region without technical reasons. The same ruling declared the ban on the construction of offshore wind installations illegal because the administrative functions relating to the use of the maritime domain are the responsibility of the State. Article 3, which subordinated the granting of permits for installation of plants to the meeting of specific limits set at 545 wind turbines, each of the minimum power of 2 MW and a total of 500 MW of power for the entire region from photovoltaic systems on the ground, was also declared illegitimate.

In fact, prior to this ruling, the Region had already taken steps to change the Regional Law no. 15/2008 with the enactment of the Regional Law no. 22/2009[4] and subsequent new guidelines[5].

In this law article 2, paragraph 1 of the Regional Law no. 15/2008 is again taken up in the version subsequently modified by the ruling of the Constitutional Court with the exception of the areas IBA (Important Bird Area) that are inserted in the unsuitable areas. The Law instead considers the possibility of installations in the SCI areas, but only after a positive result from an assessment of the environmental impact, and in the area of the Tammaro Valley and the surrounding hills.

Moreover, article 3 paragraph 1 of the Regional Law 22/2009 states that plants - not exceeding 1 MW – are authorized directly by Municipalities through the DIA (“Dichiarazione di Inizio Attività - Starting Construction Report”).

Also in this case another Constitutional Court ruling[6] stated that this exception could only be introduced by Ministerial decree and not directly by Municipalities; so the Molise Region amended its Guidelines stating that, even for installations not exceeding 1 MW, the procedure for a single authorization issued according to Regional Norms must be followed[7].

Additional changes and additions to the Law of 2009 were made by Regional Law no. 23/2010. This law reinserted the Tammaro Valley and surrounding hills in the list of areas unsuited to the realization of wind farms and photovoltaic installations, because it is one of the Region’s most important archaeological

[3] Constitutional Court ruling no. 282 of the 2 November 2009.

[4] Regional Molise Law no. 22 of the 7 august 2009 - New Rules for the installation of production plants for electricity from renewable sources in the Region of Molise.

[5] Regional Council Resolution no. 1074 of the 16 November 2009 – New Guidelines.

[6] Constitutional Court ruling no. 194 of the 26 May 2010.

[7] Regional Council Resolution no. 857 of the 25 October 2010 – Modification of guidelines for the implementation of the single procedure in art. 12, paragraph 3, of Legislative Decree no. 87/03, concerning the production of electricity from renewable sources.

contexts. Subsequently, a Council of Ministers Ruling[8] declared this Regional law to be unconstitutional because of the above-mentioned Legislative Decree no. 387/2003 which states that Regions can proceed with the identification of unsuitable areas, but in accordance with National Guidelines. In fact, according to D.M. of 10th September 2010 (National Guidelines for the authorization of plants powered by renewable sources) unsuitable zones could be identified with regard to specific sites after the completion of a thorough investigation that would identify particularly sensitive or vulnerable areas.

Finally, the Molise Region approved final guidelines for authorization to build and to manage plants producing electricity from renewable sources[9] that reproduces verbatim D.M. of the 10 September 2010.

3 FOCUS ON COASTAL ZONE

This paper presents the situation of power plants in the Region with reference to the two main types of plants installed in rural areas: wind farms and ground-mounted photovoltaic plants. The invasion of the coastal area by ground-mounted photovoltaic plants and by the large number of wind farms situated along the ridges in the pre-coastal area is very clear, especially in the eastern part of the province of Campobasso, along the ridge located between the Biferno Valley and the Fortore Valley.

In detail the paper analyzed the territorial assessment of the Coastal Zone whose main matrix appears to be agricultural-productive and its orographic characteristics favourable to agricultural practices (Cialdea, 2012). In this prevalent matrix there are also environmental excellences such as the coastal landscape, waterways designed by the main watercourse of the Region, the Biferno River, and high natural values such as SCI areas. At the same time this territory is one that has been affected by the major territorial changes that occurred in the last fifty years as a result of the settlement of the major regional infrastructure, all made along the coast of the great transformations due to the processes of agrarian land reform, the implementation settlements tourist resorts and insertion of new energy infrastructure.

The figure 1 shows the situation in the Coastal Zone of the Region and shows the number of wind farms and ground-mounted photovoltaic plants in each municipality territory. The installations are subdivided in three project typologies:

- Approved projects by Environmental Impact Assessment (EIA): wind or photovoltaic projects for which have been required the EIA act in accord to the Regional Law no. 21/200010. The EIA procedure has been positive issue;
- Approved projects only by Screening Act: projects that have been subjected to screening process and for which it isn't necessary the EIA procedure;
- Ongoing projects – EIA in progress: projects that have benne subjected to screening process and for which is necessary realize the EIA procedure.

The data refers to the procedures for environmental impact assessment (EIA) and environmental assessment (VA) used for screening wind farms and photovoltaic plants from 2000 to 2014, taken from the Molise Region's institutional website[11]. Plants already on maps, that is those greater than 1 MW, have not be considered. Most of the cases submitted to the opinion of the Regional Authority, about 90%, are

8 Council of Ministers Resolution of the 23 February 2011 - Impugnment of the Law no. 23 of the 23 December 2010.

9 Regional Council Resolution no. 621 of the 4 August 2011 - Guidelines for the implementation of the procedure as in art. 12 of Legislative Decree no. 387/2003 for the authorization to construct and operate plants producing electricity from renewable sources in the Molise Region.

10 Regional Law no. 21 of the 4 March 2000: Rules for the EIA procedure.

11 Source http://www3.regione.molise.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/660 in March 2014.

concentrated in three years (2009-2012). In some years (2000 - 2001 - 2003 - 2004 - 2006), no plant was submitted for evaluation by the Molise Region. The data shows that in the coastal areas (Montenero di Bisaccia, Campomarino, Petacciato) there is a substantial and exclusive concentration of photovoltaic plants, while in the pre-coastal territories there is a higher concentration of wind farms (Acquaviva Collecroce, Santa Croce di Magliano, Bonefro, Ururi, Montecilfone).

Projects submitted to verification in order to determine whether they should undergo environmental impact assessment (commonly called "Screening") represent 97 % of all evaluations. The procedure is intended to determine whether the proposed project may have a significant environmental impact and therefore should

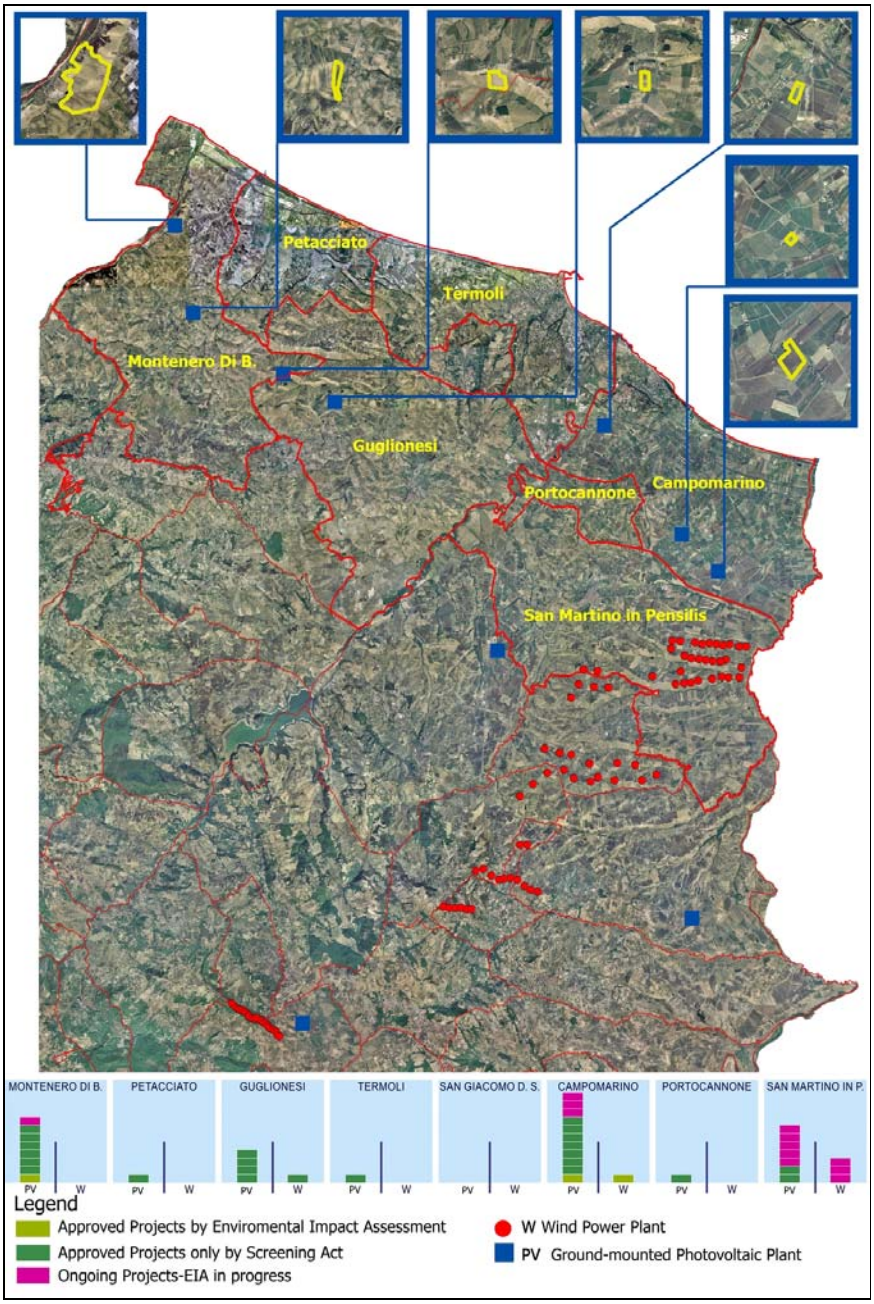

Fig. 1 Wind power and ground-mounted photovoltaic plants in the Molise Coastal Zone

be subject to further EIA procedures, or not. There are three wind power plants in the Region subject to environmental impact assessment (EIA) localized in Campomarino, Portocannone and San Martino in Pensilis, and two photovoltaic plants localized in Campomarino-Portocannone and Montenero di Bisaccia.
The figure 2 shows the Land use evolution by highlighting the major increases and decreases in the Molise Coastal Region by a diachronic analysis. The aim of this diachronic analysis was to compare two representations of the territory fifty years apart. We used data from the vegetation map of the Molise Region drafted after World War II (indicative reference year: 1954) and data from the Corine Land Cover 2006. To do this analysis the keys were standardized and then a comparative vector informative layer was used (Cialdea, Maccarone, 2012). In the analysis of the evolution of land use we wanted particularly to highlight the great territorial evolution related to changes in agricultural zones and in urbanized areas. It can be seen that the greatest changes in the coastal zone have been determined by urbanization and the expansion of the town of Termoli, of the lidos on the beaches of Termoli and Campomarino and the Biferno Valley Industrial Area near the border between these two areas. In the pre-coastal area the major transformation has been the artificial lake of Guardialfiera (figure 2 shows its different territorial situations: a: Guardialfiera Lake; b: Industrial Area; c: Lido of Termoli; d: Lido of Campomarino; e: agricultural area along the L'Aquila-Foggia cattle-track). These greatest changes are showed in the last mentioned figure. The land use predominance, especially in the pre-coastal zone, remains mainly its agricultural nature.

4 CONCLUSION

The aim of this paper was to identify a methodology of territory analysis available for the control of these new infrastructures involving rural areas, creating new forms of landscape impact (Empler *et al.* 2006, Steiner 2004). Moreover it is important verify the current land use. Also we wanted to assess how the current landscape plans, drawn up in the early 90s, provided to safeguard their territories, starting from the identification of their elements of interest. The spirit of the enforcement of the Galasso law, in fact, was to establish the area's transformability by dividing the area of each plans. In fact, as known in the Molise Region the landscape plan did not cover the all regional territory. Therefore, the analysis of the Transformability Map of the Plan no.1, which covers the coastal area, has highlighted the mode of transformations prescribed by the plan.
The actual Landscape Plans are created from documentation referred to by Art. 6 of Regional Law no. 24 of December 1, 1989, which regulates the Legislation regarding Territorial Landscape Plans.
Therefore, the project tables containing, among other things, the indications of the degree of landscape and environmental transformability of the area and the methods of protection and enhancement (according to Art. 4 of the same Act) are an integral part of the plans. These indications have been reported for all eight plans drawn up for the Region, in the Transformability Map of the area, scale 1:25,000.
The Map of Coastal Zone, shows in figure 3, defines the main characteristics of the area analyzed by dividing it into different fields of interest or risk. For each of these areas, depending on the prevailing interest, was shown a mode of transformation and the resulting land use regulations through the definition of eligible interventions by identifying the areas to be protected. In order to gain a complete picture of the transformability of the Region, all the Transformability Maps of the eight landscape plans in force have been analyzed. The problem arose in the interpretation of the keys to the plans because, having been drafted by eight different workgroups, they do not present a uniform reading of the territory even though they used the same general guidelines. The keys have been simplified so that they can be standardized.

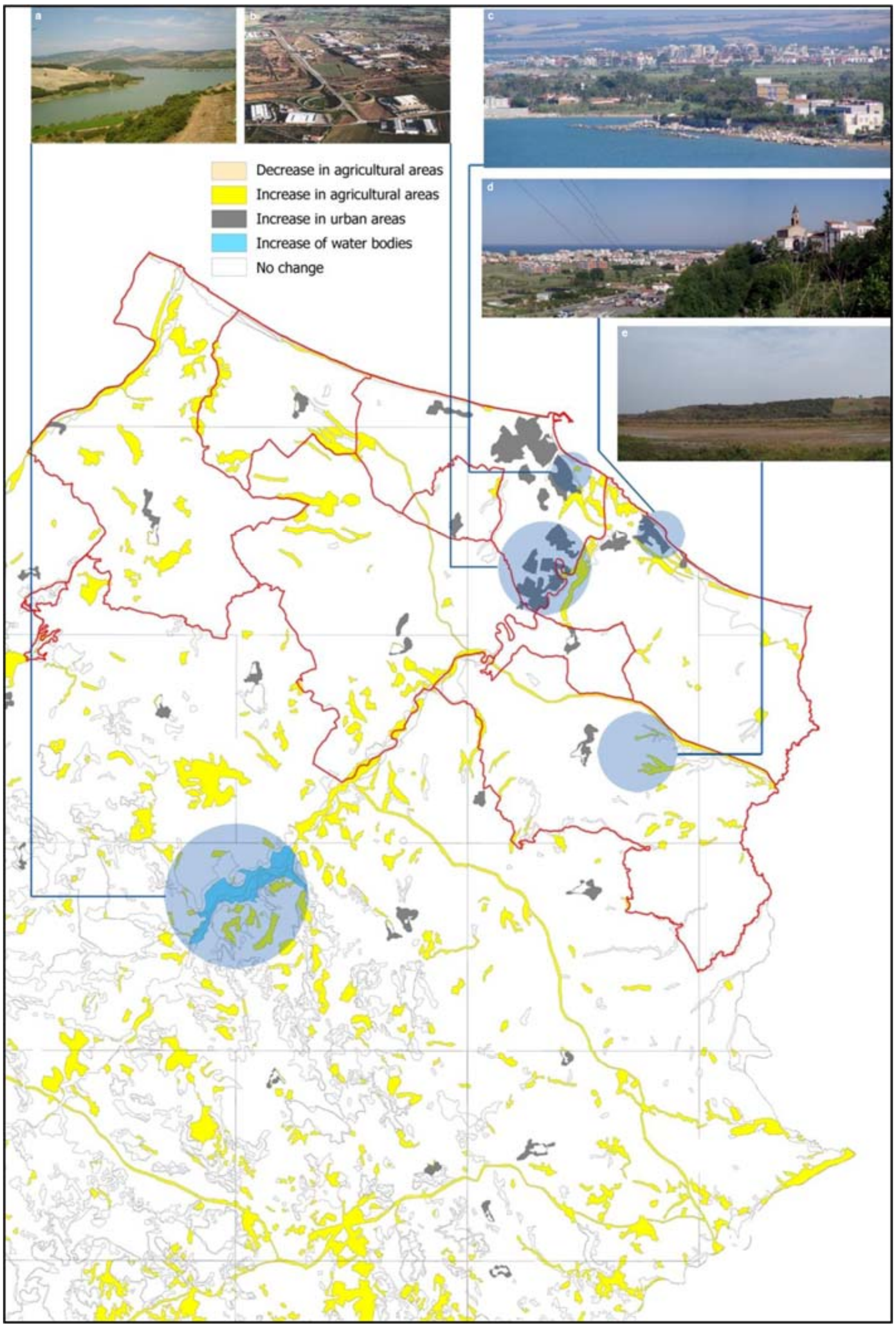

Fig. 2 Land use evolution by highlighting the major increases and decreases in the Molise Coastal Zone

This means that a number of areas have been merged in order to define the following key:

- Areas of exceptionally high naturalistic and visual interest;
- Areas of mainly naturalistic interest;
- Areas of mainly visual interest;
- Areas of mainly historical-urban interest;
- Areas of mainly archeological interest;
- Areas of mainly agricultural-productive interest;
- Areas with a balance between the elements;

- Settlement system;
- Areas of mainly geological risk;
- Pollution of soils.

The legend has been articulated in this way so as to divide the areas with positive interest and, therefore, that constitute valences for the territory, from those with negative interest which constitute a difficulty for the same territory.

Under the new code it is necessary to redefine the landscape quality aims. In the old Vast Area Landscape Environmental Plans modes of transformation of the territory were defined but in order conform to the new legislation the l.a.co.s.t.a. Laboratory of the University of Molise has been entrusted with the creation of new landscape quality aims for the Region of Molise. These aims are stated for each of the geographical areas identified in the analysis phase. There are ten homogeneous areas: Coastal Molise, Middle Biferno-Fortore, Biferno-Trigno, Biferno-central Molise, Matese, Province of Isernia, Montagnola-Upper Molise, Mainarde and Volturno.

For each of these areas the preparations for the New Regional Landscape Plan foresee the definition of the new landscape quality aims as listed in art. 135 of the Code[12] which states that "for each area the landscape plans define specific requirements and provisions, in particular:

- the conservation of the constituent elements and the morphologies of the landscape heritage under protection, taking account of architectural styles, techniques and construction materials, as well as the requirements for the recovery of landscape values;
- the rehabilitation of compromised or degraded areas;
- the protection of landscape features of the other territories, ensuring at the same time, the least consumption of the territory;
- the identification of the lines of urban development and construction, on the basis of their compatibility with the recognized and protected landscape values, with particular attention to the preservation of rural landscapes and sites included in the UNESCO World Heritage List.

Obviously for the areas previously covered by the Vast Area Landscape Environmental Plans the work started with the synthesis maps developed in the early 90s and especially from the Transformability Map.

In the first phase, an Actual state grid was produced starting from the analyses carried out during the preparation of the Vast Area Landscape Environmental Plans and in particular taking into account aspects related to the elements of environmental, landscape, historical, cultural, agricultural, productive, and demographic-tourism interest. In this phase of the work the main activities were the elaboration of this data, the standardization of the reading for all eight plans in force, the integration of analyses not only for those areas not covered by the plan, but also for those covered by the plan because the information is almost twenty years out of date.

The analyses conducted on the ten areas and on the five systems of Physical-Envronmental, Landscape-Visual, Historical-Cultural, Agricultural-Productive and Demographic-Touristic resources has enabled us to formulate targets for the Molise landscapes.

The targets identified for the entire regional area are related to the conservation, protection, management and planning of exceptional, ordinary, and degraded landscapes with particular reference to typical natural landscapes such as rivers, lakes, hills, mountains, coastal and rural landscapes, forestry and agro-pastoral, not to mention historic, rural, urban, industrial and infrastructure sectors.

12 Legislative Decree no. 42 of the 22 January 2004, Code of Cultural and Landscape Heritage, modified and integrated by successive laws.

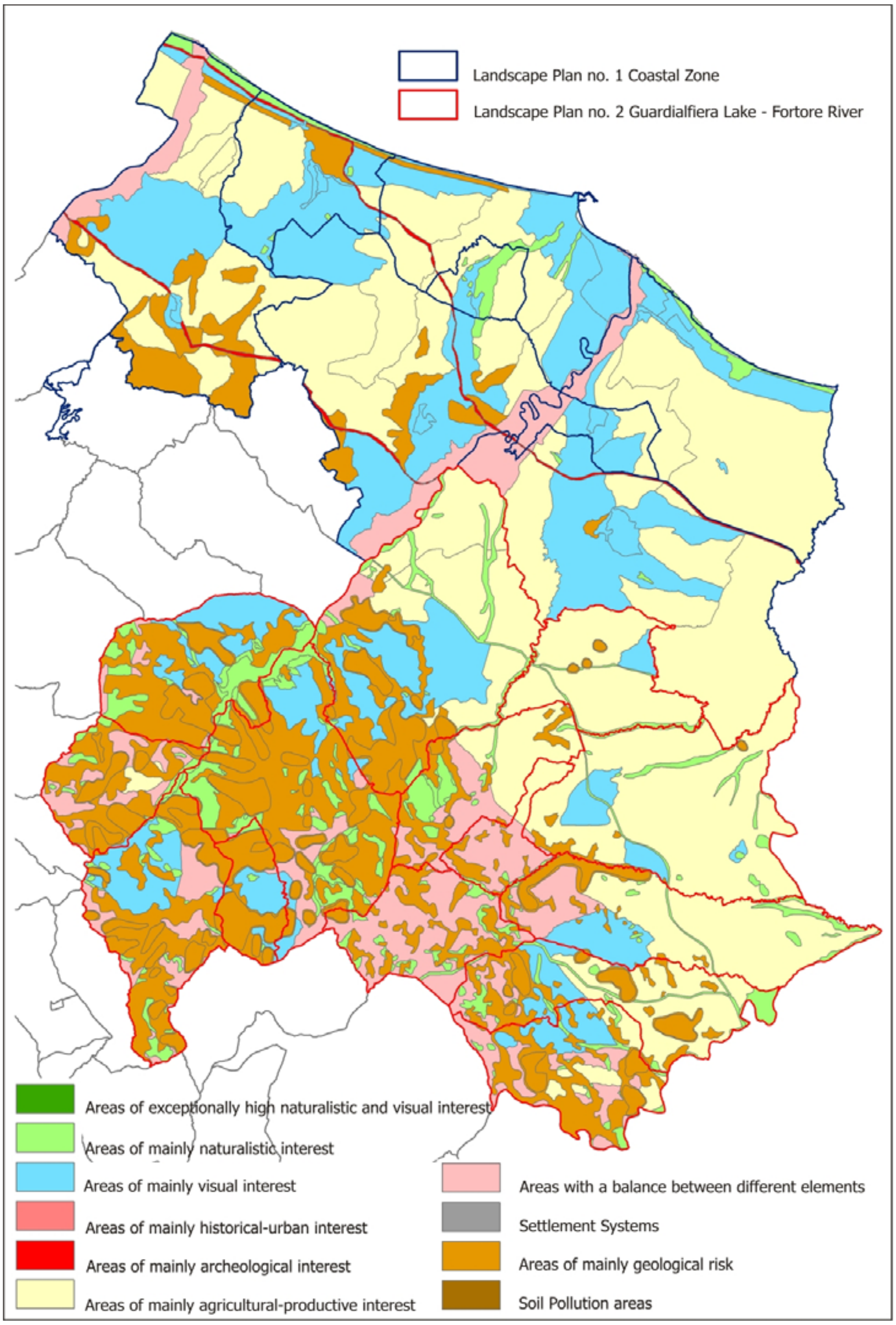

Fig. 3 The Transformability Map of the Vast Area Landscape Plans in the Molise Coastal Zone

The objectives identified are also related to the government of the processes of urbanization and abandonment of the territory and to the preservation of material cultural values and intangible values such as the traditions and history of the Region.

The definition of the landscape aims was achieved after the phase spatial analysis through the analysis of national and international case studies of good territorial governance (Casarotto *et al.* 2009).

The work group of the l.a.co.s.t.a. laboratory has identified a general objective for each resource system in which it was organized the analysis phase (Cialdea, Maccarone 2012, 2013).

The general objective was subdivided into specific objectives, as shown in Table 1.

RESOURCES SYSTEMS		GENERAL AIMS	SPECIFIC AIMS	
Physical-Envronmental System	1	Promote the preservation of the integrity of areas of high naturalness and high ecosystem value	1.1	Safeguard geological-geomorphological systems with high integrity (geological formations, ravines, cliffs, crags)
			1.2	Safeguard protected areas and areas of high environmental value such as those covered by the Nature 2000 Network
			1.3	Safeguard and improve environmental functionality of river and lake systems of Molise
			1.4	Safeguard and rebuild coastal marine habitats of Molise (coastal wooded areas, dune systems, river mouths)
			1.5	Safeguard woods and forests of mountainous and hilly areas of Molise
			1.6	Redevelop and redesign the coastal landscapes of Molise
Landscape-Visual System	2	Promote improved integration of landscape and the quality of infrastructures	2.1	Define territorial and landscape quality standards in the settlement of new network infrastructure
			2.2	Define territorial and landscape quality standards in the settlement of new energy infrastructure
			2.3	Define territorial and landscape quality standards in the settlement of new productive activities
Historical-Cultural System	3	Promote the preservation of cultural values	3.1	Preserve cultural value and witnesses of settlements and historical manufacts
			3.2	Preserve cultural value of traditional rural buildings
			3.3	Preserve the visible cattle-tacks rest
			3.4	Redevelop the historic rural landscapes
Agricultural-Productive System	4	Promote the conservation of agricultural landscapes	4.1	Develop the agricultural landscape of Molise, recognize and promote its social functions
			4.2	Preserve open landscapes of the reclamation as a characteristic aspect of identity of coastal landscape of Molise
			4.3	Redevelop the agricultural landscape of Molise
Demographic-Touristic System	5	Promote the improvement of the quality of the settlements	5.1	Improve quality of urban settlements and their environmental performance, for greater well-being of the population
			5.2	Redevelop degraded contemporary urbanization landscapes
			5.3	Improve urban quality of and touristic settlements
			5.4	Improve urban quality of agricultural and productive settlements
			5.5	Improve soft mobility quality (walking, cycling, trekking on horse) and its interconnection with the traditional mobility

Tab.1 The landscape quality aims declined for the five resources systems in which have been organized spatial data analysis carried out

Lastly, these objectives were finally associated with landscape quality directions that indicate policies to adopt and those who have an interest in achieving these objectives, as well as the measures required to adapt the urban planning instruments to the indications of the new Regional Landscape Plan.

Therefore, the landscape quality targets in this area aim to safeguard the surviving heritage in the area, to recover and improve the landscapes altered and degraded by human activity and to define quality standards for the correct insertion of new energy infrastructure in the coastal territory (Di Bene *et al.* 2006, 2007).

Finally, the landscape quality objectives aim to identify, in the sense of Art. 136 of the Urbani Code, the criteria on which to base the identification of areas to be protected through the need to initiate proceedings for the declaration of significant public interest for "complexes of buildings with a characteristic appearance having aesthetic and traditional value, including historical towns and nucleuses " and for "scenic panoramas and also public viewing points or lookout points from which such beautiful sights can be enjoyed" and dictate the rules to ensure the preservation of the values expressed by the peculiar characteristics and aspects of the territory concerned.

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Fig. 1: Orthophotos Molise Region 2008, ARPA Molise Region, our elaboration.

Fig. 2: Vegetation Map Molise Region, 1954; Corine Land Cover Map 2006; a: Guardialfiera Lake; b: Industrial Area; c: Lido of Termoli; d: Lido of Campomarino; e: agricultural area along the L'Aquila-Foggia cattle-track our photos 2010 and our elaboration.

Fig. 3: Trasformability Maps of Vast Area Landscape Plans no. 1 and no. 2, our elaboration.

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MARGINALITY PHENOMENA AND NEW USES ON THE AGRICULTURAL LAND

DIACHRONIC AND SPATIAL ANALYSES OF THE MOLISE COASTAL AREA

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ABSTRACT

This paper analyzes the evolution of land use in the Molise Region. The attention is focused on the changes that occurred primarily on the rural area of the coastal area in this Region.

The presence of urban centers of limited dimension, both for the demographic performance and for the dimensional order, is the main characteristic of this area. The historic part of rural tradition, at the same time, no longer emerges as a primary component of the regional landscape. This trend is particularly evident in the coastal zone, which is analyzed in this work not only in the range of areas that directly bordering the Adriatic Sea, but also in its pre-coastal zone, which remains imprinted on a matrix rural, but suffering from marginalization phenomena

KEYWORDS

Rural Land, Marginality, Landscape, Agriculture

1 INTRODUCTION

The geographical area's marginality comes from a large number of demographic, social and economic causes, but it takes many configurations depending on the methodological approach.
From the demographic point of view, the Molise Region is characterized by the presence of small size municipalities with fewer than 5,000 inhabitants (125 out of 136 municipalities), which cover 82 % of the total area with the middle of the regional population (Figure 1): 105 towns have less than 2,000 inhabitants and extends over approximately 65% of the region, with almost 30% of the total population, while 88 municipalities that have less than 5,000 inhabitants and population density of less than 50 inhabitants/km² appear in strong condition of depopulation.

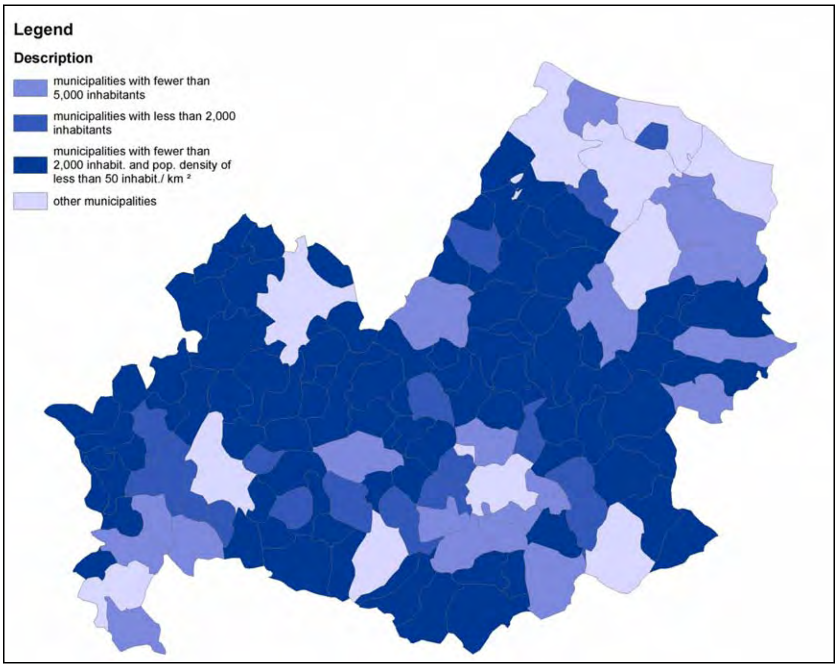

Fig. 1 Demographic Map of the Molise Region

2 THE MARGINALITY IN THE MOLISE REGION

In accordance with the OECD methodology (1994), which defines rural municipalities with population density below 150 inhabitants per square kilometer, almost all municipalities of the Molise Region (129 of 136) are classified as rural, while the provincial areas are "Predominantly rural".
The OECD methodology is mainly based on demographic criteria: however it is not able to grasp in a right way the regional marginality, which contains its own internal social and economic realities that are much more complex.
In fact the marginality condition in Molise is more articulate as well as highlighted in the past researches carried on Agricultural Land Italian Systems (Cannata 1989; Argiolas and Cannata 1980; Cannata and Forleo 1998) and on Rural Land Zoning (Molise Region 2007; Pistacchio 2008). These works take into account not only the demographic aspect, but also the physical aspect of the area, the productive structure of the agricultural sector, the relationship with other economic sectors, the condition of economic and social development .

In chronological terms, in the '80s Cannata and Argiolas identify in Molise eight Rural Systems with different levels of development. "Non-Agricultural and Attractive Systems" show a good condition and well-being: in these systems agriculture activity appears to be specialized in crops with high added value. "Integrated Farming and Attractive Systems", medium growth rate, have a good supply of urban services: their farming activity is specialized and integrated with the total economy. "Medium Autonomous Development Systems" have a condition of unbalanced development in relation to the services provision, to the quality of life and levels of consumption, despite the significant consistency of small industries, trade activities and production autonomy.

"Dependent Agricultural Development Systems" are devoid of autonomy in production and therefore depend on the most dynamic production activities: in this case municipalities are located in mountainous areas where there is a strong presence of forests and agriculture is the most significant activity. "Strong Exodus Marginal Systems" are also devoid of autonomous productive activities and agriculture does not appear to be competitive. "Ancient Depopulation Marginal Systems" show a clear situation of social and economic marginality: they are mountain areas with high incidence of wooded areas, with the agricultural use of the land in very big farms predominantly voted to livestock activities. "Medium Marginality Agricultural Systems" have a degraded economic and productive structure. "High Marginality Agricultural Systems" show situations very negative because of the presence of lower income levels, of high unemployment, of high incidence in the elderly population and of low levels of education.

At the end of the 90s, Fanelli (1998), using a broader set of indicators, identifies a new situation, different from that described above and characterized by six municipalities homogeneous groups. "Centers" have the characteristics of the medium-rich and urban areas, where agriculture is not the most important activity in terms of value added and employment. "The Lower Molise Area" is the zone characterized by a good economic development, where agriculture is competitive and highly productive, with high capital-intensive and specialized crop irrigation.

"The Inside Area Agriculture" is based on animal husbandry, that allows this system to reach higher levels of income and consumption enough, but in a social and productive context which doesn't get to production standards and demographic structures of the most dynamic areas. "The Mountain Agriculture" presents the strong delay in economic development, because of its non-competitive agriculture, connected to its state of territorial isolation with insufficient administrative services, as well as a significant rate of depopulation.

"Municipalities within Protected Areas", which are included in the National Park of Abruzzo, Lazio and Molise have a high tourist vocation, but at the same time they suffer a strong social and economic marginality due to remoteness from major centers in the region and the low productivity of natural resources.

"Municipalities based on Industrial Activities", characterized by non-agricultural development, are in good geographic location and have a good consistency of infrastructures.

In the “Molise Regional Rural Development Plan” (2007), two different typologies are identified: they are "Urban Centers" and "Rural Areas with Development Problems", which are divided into: a) Hilly Irrigated Areas; b) Hilly Rural Areas; c) Mountain Areas (Figure 2).

"Urban Centers" correspond to the most dynamic areas of the region with a good amount of services and good level of well-being; they are attributable to the two capitals of Campobasso and Isernia. "Hilly Irrigated Areas" include the coastal strip and the inland plain: despite their characterization by elements of fragility, they have some characters that are fundamentally different compared to other rural areas with development problems, particularly with regard to their competitiveness of the agricultural activities.

"Hilly Rural Areas" differ from the first one in relation to the reduced incidence of irrigated areas; this situation, also with their geo-morphological conditions, affects their agricultural production and, more generally, on their economic balance. Moreover, they are characterized by strong elements of rurality, associated with lack of infrastructures and services that distinguish them significantly from other hilly areas.

"Mountain Areas" correspond to the most marginal and peripheral areas of the region, in which geographic morphological and climatic features, influence in a negative way business decisions and consequently the levels of development of the territory.

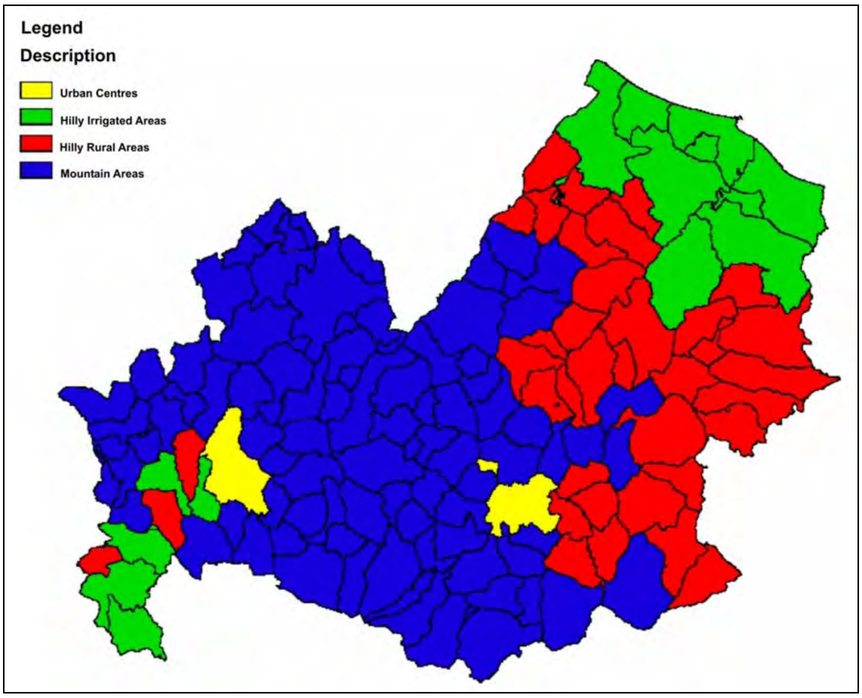

Fig. 2 Land Classification Map of the Molise Region

The result of a different zoning, performed recently by Pistacchio (2008), shows, finally, four clusters. They are: 1) "Marginal Area"; 2) "Urban Area"; 3) "Productive Area"; 4) "Medium Area". The "Marginal Area" has a low population density, a high index of old age and economic dependence, a low incidence of utilized agricultural area compared to the total utilization. The "Urban Area" is characterized by high population density and good services sector development. The "Productive Area" shows a significant use of agricultural area and a clear presence of competitive and specialized farms in irrigated crops, as well as a good percentage of employers in agriculture activities. The "Medium Area" is interposed between the Urban Area and Productive Area. It is precisely in these areas - identified as predominantly rural from regional investigations - that in recent years were made the most renewable energy installations (Cialdea, 2010 b). Our attention turns particularly to installations which have a more significant impact on the landscape - and inevitably affect the agricultural activities that take place on it - or wind power and ground-mounted photovoltaic plants (Figure 3).

3 THE TERRITORIAL SYSTEM OF THE COASTAL AREA

The coastal zone of the Molise Region is our sample area. It is a short coastline of about 35 km which presents, however, some different situations. First of all, it is characterized by the mouths of three rivers, the Trigno River, the Biferno River and the Saccione River, but there are many other strong elements.

However there are three ports, some already realized for a long time and others more recently existing.

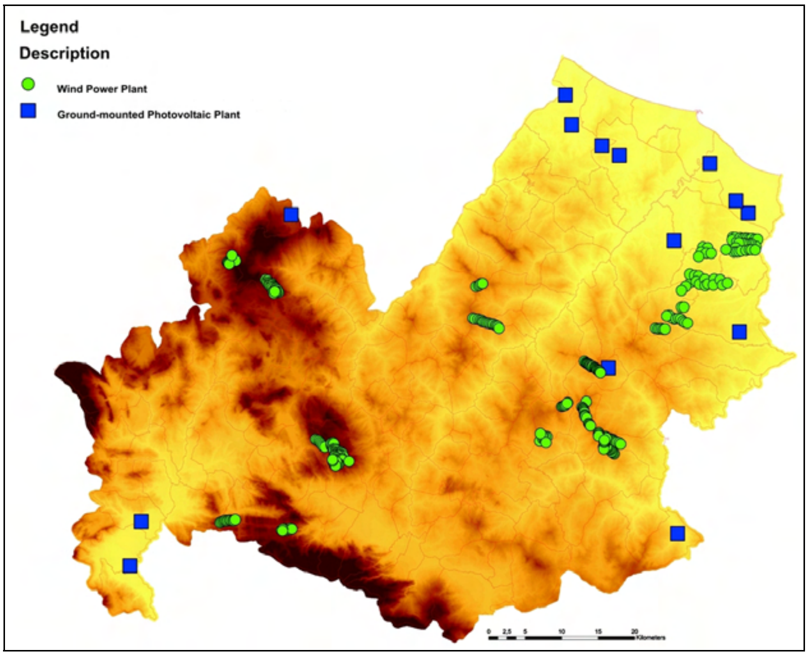

Fig. 3 Wind power and Ground-mounted Photovoltaic Plants in the Molise Region

For the Termoli harbor, built in 1905 (it was designed in 1890 but it was not then authorized), successive new extensions undergone; in Campomarino the port, though not completely, was recently realized, even in Montenero di Bisaccia there is a new port, on which there were in many debates.

There is, then, the strong presence of the industrial area, the largest and most started in the region , which is stationed near the town of Termoli.

In this area, finally, significant remediation of wetlands were made from the late 50s, which have changed the aspect and the land use of most of the coastal and pre- coastal zone (Cialdea 2009). The coastal area is covered by the *Landscape Plan No. 1 Coastal Area*, for a total of 48 434 hectares[1], and it is, of course, never returned to any Mountain Community.

Moreover, in the last fifty years there were considerable changes in land use (Cialdea et al. 2006, 2007a, b).

First of all, there was a net decrease in areas with shrubs and bushes that it turns into an agricultural area.

Only in few circumstances, where agriculture activities appeared uncomfortable because of the area's topography, agricultural zones were abandoned: consequently these areas have slowly naturalized (this is the case of the wooded areas along the Tecchio River, near Petacciato, which before were devoted to agricultural uses).

A Campomarino , however, we see the opposite phenomenon: in Ramitelli locality, forest areas disappeared to take place for agricultural use.

Another growing problem is the disappearance of the dune system: on the coast of Molise today do not have that few residual areas, often remained only by chance. This ecosystem degradation began with the early works of reclamation of the Adriatic coast, but in more recent times it had a large increase. In fact, the coastal building development, which was spontaneous, chaotic and deregulated, pushed the anthropic presence more and more close to the shoreline, destroying the sparse vegetation typical of the dunes and

1 In this area the geological constraint is extended to almost 50% of its surface. The archeological sites are significant in the municipalities of Campomarino Guglionesi, San Giacomo degli Schiavoni and San Martino in Pensilis and the tracks involving the municipalities of San Giacomo and San Martino.

leveling the dunes themselves for their own purposes. All along the coast, therefore , there is an increase in number and size of urban areas. This phenomenon is particularly concentrated around the town of Termoli (already in the 90s, there was a consistency of urban areas equal to 10 times that of forty years earlier). The analysis carried out for the definition of the land use (Figure 4) bring out the clear vocation to agricultural production: in particular, land valley and irrigated areas along the hillside are considered as exceptional value, both for their geo-pedological asset and for their cultural attitudes (Cialdea *et al.* 2010a).

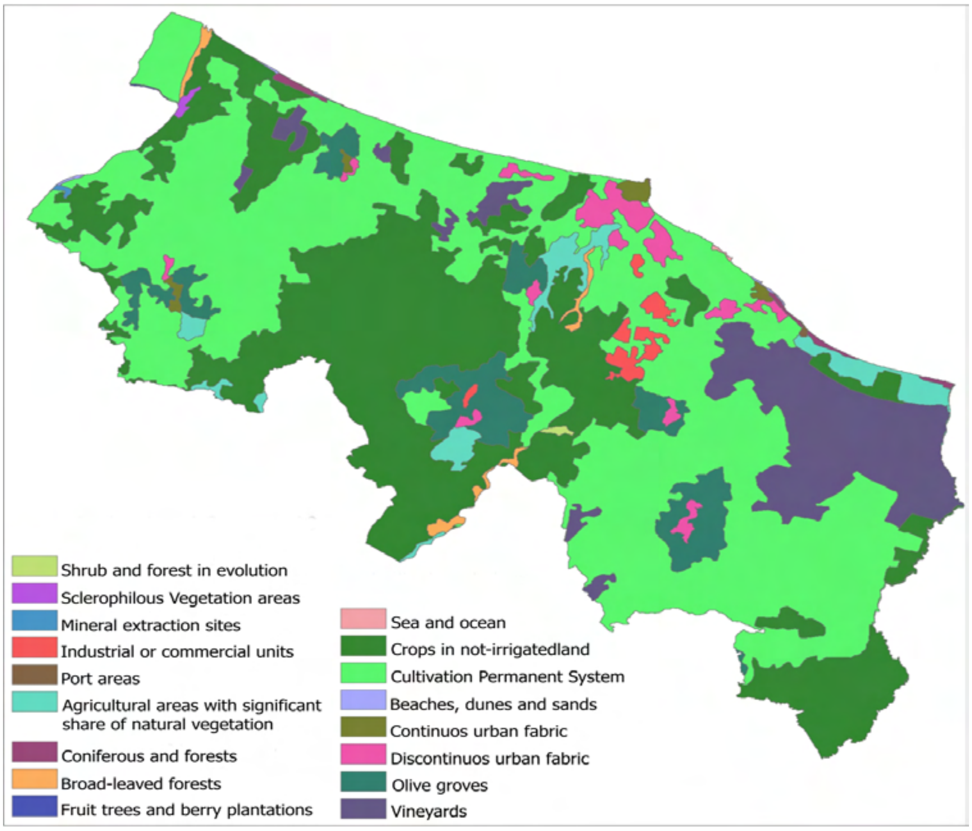

Fig. 4 Land use analysis in the coastal area

Areas along the Biferno and Trigno Rivers, and in general all coastal areas, are considered by the plan of exceptional natural interest: there are, in fact, areas that were then proposed as Sites of Community Importance, reflecting the presence of flora and fauna as important to highlight the need to protect their biodiversity. These are: the dune habitat in Campomarino, rare flora in the coastal area near the Saccione River; the wetland biotope in the district of Salcete in Guglionesi on the left side of the Biferno River; the habitat suitable for aquatic species along the Tamburro River (it is currently the only wetland remaining in the stretch from the Liscione dam to the Biferno's mouth) which is characterized by the presence of holm-oak Mediterranean forests. Worth less, but similarly important elements in this area, are the coastal wetland typical of the Mediterranean basin located near the mouth of the Biferno River- and therefore in an area subject to intense human activity - and the forest named Fantine in Campomarino, currently extremely devastated by the presence of activities, including a dump, but potentially recoverable thanks to the remains of holm oak survivors. Moreover, in the actual Landscape Plan, there are different areas characterized by the visual interest such as peak lines and hilly performances. It is necessary to underline the exceptional importance of the so-called headland of Campomarino, that put Campomarino in a panoramic location.

Elements of geological hazard have been identified in Petacciato landslides, in Montenero di Bisaccia and Guglionesi landfall and also in Montenero di Bisaccia along the right side of the Trigno River. In essence, the coastal zone is certainly the part of the region with the major transformations, in the area which is also highly exposed to anthropogenic pressures, especially those linked to the increase in tourism. Of course, also the creation of reservoirs and the abundant mining activity contributed to the actual condition of the landscape feature, particularly in the coastal area, where the already mentioned urbanization occurred rapidly and without effective checks both for the settlement of industrial settlement and for urban increase.

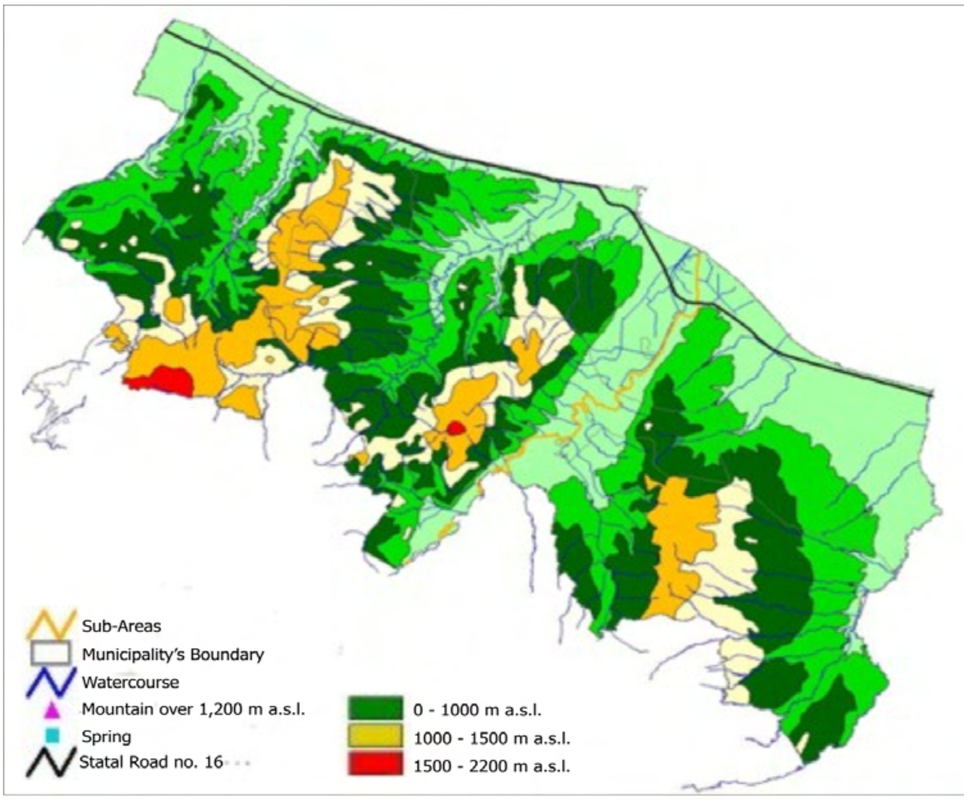

Fig. 5 Landscape visual analysis in the coastal area

However figure 5 describe our interpretation of the landscape in this zone: the coastal area could be divided into two sub-areas. The demarcation is essentially signed by the Biferno River. In its right side there is the area with the higher soil fertility and where farming activity is more developed, also as a result of the past land reclamation. In the left side of the Biferno River there are the greater phenomena related to the human activity, to the expansion of the urban area of Termoli and especially to the presence of the industrial area.

4 THE PRODUCTION SYSTEM OF THE COASTAL AREA

This study area has a clear condition for development and economic diversification with respect to the regional framework .

Industrial activities and services play an important role in the town of Termoli. This condition is significant also in the industrial Map of Italian Localism (CENSIS 1982). In the industrial area of Termoli, that reaches the top of specialization with the participation of the mechanical industry, diversification of production grew up in the direction of agro-food and chemical industries. Starting in '60's, there was a significant increase in local units of industry and services. In 1961 there were just 1,681 local units, while in 2010, local units amount to about 50 000. Really there are significant differences between different National Census. In fact, over the past few decades the increase of local units had a lower intensity compared to the period 1971-1991. The result is, therefore, a framework that emphasizes a clear outsourcing of the production system.

At the local level, the positive trend has mainly affected Termoli and more lightly Montenero di Bisaccia and Campomarino. In 2011, tourism has a consistency of 180 structures, with a high prevalence of complementary ones (150 units) compared to the hotels. The accommodation capacity is 4,791 guests: the hotel facilities offer 1,881 beds. Complementary exercises, however, are more receptive availability (2,910 beds). In relation to the hotels, data referring to 1998-2011 reveal a clear increase in the number of beds (+530 units). The extra-hotel capacity, however, showed a steady decrease in the number of beds in the villages and camps, while the consistency of the tourist and hotel residences increase and facilities so-called environmentally friendly (cottages, B & B) consolidate. In 2000, farms amounts to little more than 6,000 units, while the SAT and the UAA amounted respectively to 37 708 hectares and 35,909 hectares. The average farm size is relatively small (a little over 7 hectares). The impact resulted from the agricultural area close to 95% of the Total farms land.

In 2000, farms amounts to little more than 6,000 units, while the Total farms Land and the Agricultural Land amounted respectively to 37,708 hectares and 35,909 hectares. The average farm size is relatively small (a little over 7 hectares). The impact resulted from the agricultural area close to 95% of the Total farms land.

Agriculture suffers a drastic restructuring and tends to specialization and intensification. Between 1950 and 2010, the farms number increased slightly, except in Montecilfone, Petacciato and San Giacomo. In contrast, the Total farms Land and the Agricultural Land is greatly reduced in each Municipality, except in Campomarino Montenero di Bisaccia and San Martino in Pensilis. Consequently, the average size corporate decreased significantly. This condition is to be read in relation to the actions of land reclamation.

The land structure does not detect phenomena of sputtering but since the 90s in almost all areas there were a decline in the share of the Agricultural Land of farms with over 50 hectares.

Irrigation played a very important role for the development of this area, where rainfall is scarce and poorly distributed over the course of the agricultural year. Irrigation developed in the 80s, thanks to the use of water resources of the Guardialfiera Lake, which has a usable capacity of about 137 million cubic meters of water. In 2010, irrigated areas totals more than 5,000 hectares and affect significantly all the municipalities in the area: it is a phenomenon that must be carefully assessed in terms of farming but also the environmental impact (Forleo *et al.* 2011). Data relating to farms indicate a widespread presence and extensive use of irrigation. More than half of farms use irrigation for a coverage of more than 70% of their irrigable area. The percentage of irrigated area in the total Agricultural Land takes significant values in Campomarino, Guglionesi, Petacciato, Portocannone and Termoli. Irrigation affects mainly horticultural crops, industrial plants (sugar beet) and fruit trees. Great importance have dynamics of the production structure of the area: in 2010, the production scenario appears to be more varied than in the 50s. Data reveal, however, a clear decrease of arable land and permanent grassland. In contrast, permanent crops showed a significant increase. Moreover the forest increase appears smaller. The weight of the arable land unchanged, the incidence of meadows and pastures reduced, while there is a significant increase in permanent crops. The so-called "other land" almost disappeared. With particular reference to wine production, it is appropriate to emphasize the special vocation of agriculture in the area and the importance of the production of DOC and DOCG area.

The livestock farming is marginal in the context of this area, although in recent years there were a slight increase in the number of farms in Campomarino, San Martino in Pensilis and Petacciato.

The spread of organic farming in the study area is relatively low: farms that adopted organic production amounted to just 108 units (Molise Region, Department of Agriculture 2008). The Total farms Biological Land is 512.35 hectares, while the Agricultural Biological Land covers an area of 291.68 hectares.

At the municipal level, the analysis shows that Petacciato is the Municipality with the majority of biological land, which represents the 44.2% in terms of Agricultural Land and 49.8% in terms of Total farms Land.

In Guglionesi the biological surface amounts to 91.49 hectares and 74.38 hectares of Agricultural Land (25.5% of Agricultural Land and 17.9% of Total farms Land). In Campomarino the Total farms Land and the Agricultural biological Land amounted to, respectively, 29.89 and 18.6 hectares. In Termoli, the Total farms Land and the Agricultural Land correspond, respectively, to 6.01 and 3.94 hectares (1.4% of the Total Agricultural Land and 1.2% of the total farms land). The result is a framework that emphasizes a clear process of specialization and intensification of agriculture, which created environmental problems and simplification of the landscape.

The study area has a clear interconnection between production specialization and Municipalities in which there is a greater concentration of employment levels. Employment grew significantly only in the last thirty years. The occupational structure undergoes a profound change. Since the 60s there is, in fact, a progressive reduction of the employed in agriculture and consequently employment growth in industry and services. In percentage terms, the weight of the labor force in agriculture, which in the past was the most consistent activity, down from 59% in 1961 to just over 8% in 2010, compared to an increase in industry (from 23% to 37%) and services (from 17% to 54%). The agricultural sector was, therefore, a sort of reservoir for industrial activities and more recently also for the tertiary sector. The last period is characterized by a much lower decline of assets in agriculture, by a gradual increase in the industrial sector and a persistent increase in the services sector. In any case, about 90% of the workforce that supports industrial activities comes from the agricultural sector.

The disaggregated analysis within Municipalities, highlights how the evolution of the employed in the reporting period was substantially different. With the exception of Termoli , which has seen a sharp increase in employment (+60%) , the remaining municipalities have suffered a consistent decrease.

Profound changes occurred: if in 1971 it was still possible to identify Municipalities with workers in agriculture that exceeded the 50% (Campomarino, Guglionesi, Montecilfone, Montenero di Bisaccia, Petacciato, San Giacomo degli Schiavoni), already in 1991, no one Municipality exceed this threshold.

Termoli absorbed 90 % of the increase in industrial employment, while, as regards tertiary activities, all Municipalities registered, an increase in the number of workers. In 2010, agriculture employers are eloquently in Montecilfone (18%), while in Termoli are less than 5% of the labor force. The working units in the industrial sector have an important place in Montenero di Bisaccia (47% of the total), while those employed in the services sector showed a significant consistency in Termoli and San Giacomo degli Schiavoni (respectively 60% and 57%).

The scenario described, on the one hand, defines this district as the so-called "strong areas"; on the other hand it highlights how significant changes undergone in the economic structure, that is in a phase of consolidation.

5 CONCLUSION

The analysis of renewable energy installations highlights how the area most affected, especially from wind farms is the right Biferno hills. This area, as previously described, is higher fertile and characterized by greater agricultural activity. Moreover the Landscape Plan no.1 highlights that these areas are characterized by a high production value[2]: they are the low hills of Molise between the territory of San Martino in Pensilis, Ururi and Rotello.

On the other hand, these areas possess significant or even higher visual interest, always in accordance with the plan, which described these hill areas such natural formations soil of visual elevated value[3]. Moreover photovoltaic systems have been installed, for the most part, on agricultural land which is of elevated agricultural production value.

Within the general framework of the Region, the study area is the most devoted to the tourism industry and its coastal location, at the same time, it is also one in which the major intensive agriculture activity is concentrated, thanks to favorable climatic conditions and good availability irrigation in addition to the presence of some valuable productions, including the biological ones.

This area is an example of Italian Localism, but the economic dynamics have not been able to consolidate relations between Municipalities, nor to interact with the regional productive fabric.

Moreover, the production of energy from renewable sources is a national priority as it increases the security of energy supply, promotes employment and helps to reduce the environmental impact associated with the energy cycle, but of course the plants planning must necessary take into account the characteristics of the territory, specifically in relation to he impact on productive activities that are predominant in it.

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IMAGES SOURCES

Fig. 1: ISTAT Data with reference to 2011 year, our elaboration.

Fig. 2: Molise Region, Regional Rural Development Plan 2007.

Fig. 3: DTM Molise Region, investigation on present plants ARPA Molise Region, our elaboration.

Fig. 4: Corine Land Cover 2006, our elaboration.

Fig. 5: Molise Region Vegetation Map, our elaboration.

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SPATIAL ANALYSIS OF URBAN SQUARES

'SICCOME UMBELLICO AL CORPO DELL'UOMO'

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ABSTRACT

Urban squares, despite their apparently self-evident consistency, actually represent one of the most uncertain issues of present urban planning. Denied and neglected by modern architecture, then sought after in the last decades, squares are commonly recognized as fundamental identity making elements in urban settlements as well as in their respective communities. Since their revival in the late '900, the design of urban squares has been a challenging task for generations of planners and urban designers, since, despite any effort, most of the squares worked out can hardly succeed in competing with the historic ones. What appears to explain the failure of most attempts is the actual uncertainty in the definition of what an urban square really is, or should be: not a mere open space, nor only a pedestrian path, nor necessarily a wide or regular space, nor always a junction of streets. Perhaps all these things together, but also something more, what makes the matter to overcome the limits of a strictly physical vision to approach social and cultural meanings.

The purpose of this research is therefore to investigate around the link between spatial aspects and social issues, so as to identify the spatial features that allow an urban square to actually play a social and cultural role.

As a testing ground of such effort a wide set of Italian squares was assumed as a case studies series, in order to catch the spatial code of their success as relation and public representation places; and some configurational parameters will then be proposed for reproducing such capability, so as to actually support the planning and design of urban squares.

KEYWORDS

Urban squares; spatial analysis; grid configuration

1 INTRODUCTION

"*La piazza principale debba in nel mezzo e centro d'essa città, o più propinqua a quello che si può, essere collocata, siccome umbellico al corpo dell'uomo*"[1]

Francesco di Giorgio Martini, Trattato di Architettura Civile e Militare (1482)

Urban squares, despite their apparently obvious and self-evident consistency, actually represent one of the most uncertain and disputed issues of present urban planning. Central element in traditional urban design (as epitomized by the famous rule by Francesco di Giorgio Martini), denied and neglected by modern architecture, then sought after in the last decades, squares are commonly recognized as fundamental identity making elements in urban settlements as well as in their respective communities. Since their revival in the late '900, the design of urban squares has been a challenging task for generations of planners and urban designers, since, despite any effort, most of the squares worked out can hardly succeed in competing with the historic ones. What appears to explain the failure of most attempts is the actual uncertainty in the definition of what an urban square really is, or should be: not a mere open space, nor only a pedestrian path, nor necessarily a wide or regular space, nor always a junction of streets. Perhaps all these things together, but also something more, what makes the matter to overcome the limits of a strictly physical vision to approach social and cultural meanings.

A square is a public open living space, the meeting and relation space par excellence, where people do meet and gather day by day, so that the term itself gets easily extended to other meanings: in Italian common speaking, "scendere in piazza" (literally "to go down to the square") means to revolt, "aizzare la piazza" (literally "to excite the square") means to arouse riots, "abbandonare la piazza" (literally "to abandon the square") means to get off the public stage, "ascoltare la piazza" (literally "to listen to the square") means to sound out public opinion, "mettere in piazza" (literally "to put into the square") means to publicize and spread news, "rovinare la piazza" (literally "to ruin the square") means to damage one's reputation; and so on, thus demonstrating that in current Italian speaking the square does definitely stand for the people, the physical representation of its community meaning.

The purpose of this research is therefore to investigate around the link between spatial aspect and social issues, so as to identify the spatial features that allow an urban square to actually play a social and cultural role. And the ideal key for such investigation is the configurational approach, in that it focuses on the urban grid and appraises its as the very interface between the physical and perceivable city, made of streets, squares, blocks and buildings, and the phenomena (both material and immaterial) that occur along its paths.

Space Syntax is based on the assumption of the primary role of the urban grid in the making of urban phenomena (Hillier, 1996a); in that it regards the urban space as a "common medium of the physical city and the experiential city as well as of the socio-economic city and the cognitive city" (Hillier, 2005), it will hence the key for searching the spatial features, if any, that make an urban open space suitable for actually working as a meeting and relation place, that is a square.

As a testing ground of such effort a wide set of Italian squares (Piazza San Francesco in Arezzo, Piazza del Popolo in Ascoli Piceno, Piazza della Signoria in Florence, Piazza Grande in Leghorn, Piazza del Duomo in Parma, Piazza della Cisterna and Piazza della Collegiata in San Gimignano, Piazza del Campo in Siena, Piazza San Marco in Venice, Piazza dei Priori in Volterra, among the most renowned ones) was assumed as a case studies series, in order to catch the spatial code of their success as relation and public representation places;

[1] 'The main square must be located just in the middle and centre of the city, or as near as possible, as the navel in human body'.

and some configurational parameters will then be proposed for reproducing such capability, so as to actually support the planning and design of urban squares.

2 BACKGROUNDS

As mentioned above, the configurational approach was assumed as the tool for investigating around the spatial features, if any, which make an urban open space suitable for effectively working as meeting, relation and interaction place, that is a square. What suggested it is the fact that such approach is based on the primary role of the urban grid in the phenomena occurring along its paths, in particular movement distribution and activities location. Roughly speaking, the grid configuration is what actually indicates and suggests the likely distribution of movement flows and hence the pre-condition for the use of urban land (Hillier, 1996b). In order to materialize this relational features, several operational techniques have been so far proposed, experimented and widely discussed; while all those techniques share the same conceptual bases of the configurational approach, as a matter of fact they appear to divide with reference to the specific way each of them indicates for reducing the urban grid (the primary element of urban phenomena, as announced above) into a system, and hence to the spatial elements to be selected, observed and provided with configurational values.

The so-called axial analysis was the first configurational technique to be introduced in 1984 (Hillier, Hanson, 1984), and is still by far the most widely diffused; it reduces the grid into a complex of intersected segment, the axial lines, which compose the so-called axial map, the system to be analyzed. The visibility graph analysis, or VGA, reduces the grid into a system covering it with a mesh of dots, called vertices, in mutual visual relationship, composing the so-called visibility graph. The convex analysis reduces the grid into a system of polygons, called convex spaces. All the configurational techniques are actually aimed at providing each element of the system with a full set of numeric parameters, to be assumed as configurational variables, suitable for reproducing the configurational state of the system. Some of them deserve a particular attention. Connectivity is the configurational equivalent for the notion of degree in graph theory and is the number of elements directly connected to the observed one. Integration is the configurational equivalent for the notion of closeness in graph theory and is the mean depth of the observed element with respect to all the others. Choice is the configurational equivalent for the notion of betweenness in graph theory (Freeman, 1977) and is the frequency of the presence of an element in the shortest paths mutually connecting all the couples of other elements.

While the first one – connectivity – is a local index, in that it is computed taking into account only the observed element and the surrounding ones, integration and choice are global parameters, since they result from the consideration of the whole grid of the settlement. Beside them, which are shared by all the configurational techniques, other more specific parameters were introduced as exclusively referred to some of them; in particular, the so-called clustering coefficient measures the degree to which nodes in a graph tend to cluster together, that is how concentrated the neighbourhood of that node actually is. In VGA, the clustering coefficient of a vertex is the ratio between the number of visual connections within its own isovist and the number of those that could in theory exist. Clustering coefficient hence reproduces the degree of convexity of the isovist of a vertex, or, in other words, its level of intervisibility, that is how many vertices do share the same isovist (Turner et al., 2001).

A large amount of studies and researches has gone discussing and demonstrating the capability of those indices to represent significant urban aspect, and to reproduce and simulate several variables and phenomena. Above all, the integration value, which is by far the most used and significant configurational parameter, was widely demonstrated as a reliable indicator of urban accessibility; if the notion of accessibility is intended in terms of attractiveness towards activities, and if it is regarded as 'pure' (that is depending on the spatial relationships on the grid and not on the presence of the located activities), the integration value was in fact demonstrated able to reproduce its distribution, and therefore, the distribution of positional appeal (Cutini, 2001). Those results, on the other hand, appear to correspond to the intrinsic meaning of the notion of integration, that is the mean closeness or proximity of an element with respect to all the others. In that integration takes into account the proximity of an element to the others, it materializes its potentiality as a destination point from all the locations. Integration value can be concretely computed either in a global view (taking into account the elements of the whole grid, so as to obtain the global integration) or in a local view (computing only the elements lying in a topologic circle with radius R around the observed one; usually R= 3 and the resulting index is called local integration, or radius 3 integration). Choice value is quite a different matter: in that it takes into account the frequency of the presence of an element in the paths connecting all the others, it materializes the distribution of through movement. In other words, it expresses and measure a different kind of urban centrality, based on movement rather than on proximity: rather than pinpointing an element as an ideal location for activities (as integration), choice indicates and hence narrowly reproduces the distribution of movement, and therefore the optimal location for activities movement-oriented. Connectivity reproduces the spatial potentiality of an urban location as a point of local connections, hence measuring how many locations can be directly reached (or perceived) from a given urban space. In VGA such index is called neighborhood size, as it measures the spatial dimension of the actually perceived urban area from the observed vertex; since the vertices are uniformly scattered within the urban space, the neighborhood size is obviously proportional to the metric dimension of that area.

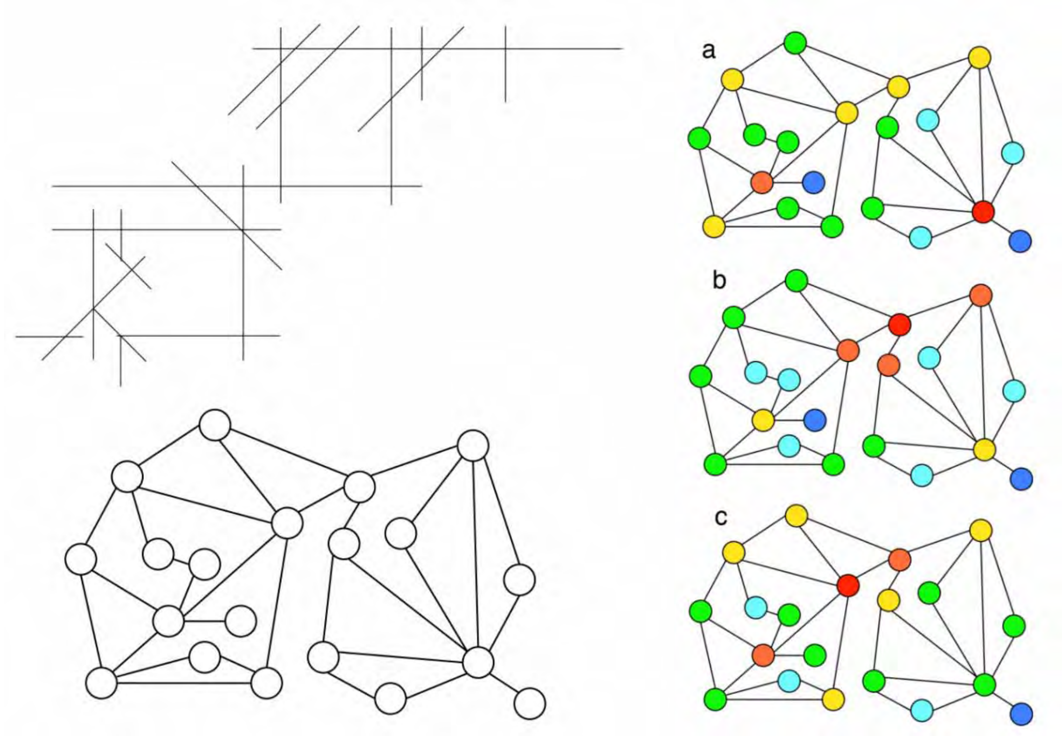

Fig. 1. An example: an axial map (top left) and its correspondent graph (below); on the right, distribution of connectivity (a), choice (b) and integration (c) values in the graph. Warm colours (up to red) stand for high values

Summing all up, and roughly speaking, the three parameters mentioned above (integration, choice and value) can be assumed as different indicators of urban centrality; or, better, they indicate different kinds of urban centrality, which can even not coexist, how it can be observed in the axial map of figure 1, relationally represented by the graphs on the right: here three different nodes are respectively provided with the highest values of connectivity (a), choice (b) and integration (c), thus materializing the differences discussed so far.

3 GRID CONFIGURATION AND URBAN SQUARES: METHODOLOGY

The common experience of Italian urban settlements points out a specific bi-dimensional element – the piazza – whose presence cannot but be recognised as one of the most prominent elements in the genesis and consistency of urban settlements, so as to be acknowledged in most cases as the very heart of the city. Here the Italian term piazza is deliberately used, since the English translation into ‘square’ could hardly appear appropriate and satisfactory: in Italy a piazza is not a mere open space, nor a pedestrian path, nor necessarily a wide or regular space, nor always a junction of streets. Probably (or, better, often) all these things together, but also much more. A piazza is a public open living space, the meeting and relation space par excellence, where people gather day by day. Such an important significance is proved by the presence, within each Italian urban settlement, of a main piazza, generally hosting the prominent political, administrative and religious activities and the most frequented public uses and events, so that it is plainly assumed as the heart of the public life of the town. This kind of role is particularly evident in small and medium size towns, where only one place within the settlement stands out with those features.

Although in the following the Italian term will be presented translated into square, we are at pains to advise the reader of its actual intended meaning.

The issue with this research can hence be presented as follows: is it possible to identify the configurational features of a square? Or, in other words, can we find a configurational setting such as to assign an urban open place the functional role of a square? Definitely, can we configurationally recognize a square? As it was shown above, the very reason for applying a configurational approach to the investigation on city squares is the fact that it focuses on the shape of the urban grid and appraises its features as the interface between the physical city - the streets and squares, as well as the blocks and buildings aligned along them - and the phenomena (both material and immaterial) that occur along its paths.

‘Paradoxically, the real challenge to our two city paradigms comes not from the well-formed, well-functioning city, but from its - real or apparent - pathology. Where cities seem to go wrong, often as a result of belief-based interventions which come in time to appear mistaken, the problem of one city confronts us with immediacy and urgency by demanding to know if there is any sense in which the physical and spatial form of our interventions has contributed to their apparent failure’ (Hillier, Vaughan, 2007). On such regard, urban squares can be seen as an ideal field: squares as relation places are constantly present in urban projects and emphatically highlighted; from renewal urban projects up to the new development plans and even in the far remote shopping mall around the edge of the sprawled city, a square appears as the pivot element of public space. Nonetheless, such planning challenge often are unsuccessful: although aimed at becoming meeting and relation spaces and to catalyze social life, most of the squares worked out in last decades remain lacking in movement, crowd, activities. What arouses the question this research is concerned with: why on this regard the two cities don’t match? Or, what prevents the physical city to meet those social, cultural and functional needs? Or even, more specifically: how an urban square ought to be planned and shaped so as to actually comply with the functions it is requested for?

In order to identify the configurational setting suitable for assigning (or recognizing in) an urban open place the functional role of a square, such role, from a social and cultural point of view, ought to be primarily identified. Given the functional role, it will be easier to search for the spatial features suitable for fulfilling it.

Of course an urban square, as a prominent public space of the community, is provided with a whole amount of cultural and social meanings, mainly referred to political or/and religious representativeness, which both the geometric features of the space and the architectural features of the buildings are to assume and materialize and the presence of monuments concur in enhancing; and those meanings and representative role ought not to be ignored or neglected. Nonetheless, the prominence of squares cannot be reduced to the mere architectural relevance of buildings and monuments: outstanding urban squares do actually appear lacking in monuments prominent buildings; as well as outstanding architectures and monuments often can't succeed in making the encompassed space a real and working square. The key factor for squares should hence be elsewhere; and, as far as concrete functions are concerned, and referred to the whole settlement, the matter is mainly relational. Gathering, meeting, interacting: these are the functions and the social purposes of the urban open spaces should be aimed to, so as to be properly called squares; or, better, to effectively be suitable for working as squares. In long-lasting quarrels as well as in several historic essays on city planning, regarding a city as a community house, squares have been commonly defined (and undoubtedly, to a certain extent, are) urban rooms, the public spaces par excellence, where people do gather, do meet and do interact. Even in common speaking, the notion of square is tightly connected with the functions of gathering, meeting and interaction; as a basic example, even in virtual reality, terms as agora or forum clearly evoke and represent the function and place of meeting and interaction that in physical cities an urban square actually materializes.

In configurational terms, gathering means integration, meeting means choice, interacting means connectivity. More in detail, in fact, the potentiality of an urban place so as to favour interaction deals with the richness in its connections, so that that place can be perceived and directly reached from a large amount of other places. The capability of a place to represent a meeting point cannot but deal with the number of the paths actually sharing that place, where therefore they meet and intersect each other, no matter where they come from or go to. The effectiveness of an urban place for gathering people depends on its actual accessibility, that is, in configurational terms, in its integration value: high values of global integration do, in fact, stand for high proximity to all the other places all over the settlement, and hence high attractiveness potential. We can hence assume that squares ought to be provided with concomitant high values of connectivity, choice and global integration, possibly over the respective 90° percentile, so as to be located within the connectivity core, the choice core and the integration core. Yet, something else, more local, should be provided: since an square is a container (of gathered people and their interactions) few local (that is geometric) properties appear necessary: first, for what concerns the physical dimension, a square ought to be capable to encompass people, by and large the whole community, thus requesting some prominent size. This further feature can be exactly reproduced by the mean value of neighborhood size within a convex space. Moreover, for what instead regards its morphology, such container should appear as enclosed as possible, being surrounded and encompassed by some continuous material boundary (walls, buildings); a strong enclosure is then expected to provide squares with a feeling of human-scaled outdoor rooms.

Lastly, as intended at favouring meeting and interaction, the square would be expected convex, thus made by points in direct and mutual visual connection. This last property was well synthesized by the fitting expression of a square as 'luogo degli sguardi (place of glances)' (Portoghesi, 1990), spatial unit where everyone can see (and be seen by) each other and interact with each other. The mean value of clustering coefficient appears suitable for narrowly reproducing this spatial feature, in that it expresses the degree to which the vertices of a convex space share the same isovist, and hence the level of intervisibility they are provided with. Summing all up, we have so far identified three non-local (that is relational) properties and three local (that is geometric) properties, which the configurational techniques appear suitable for recognizing, appraising and even measuring. For what concerns the operational tool to be used, some discussion on the existing configurational techniques will be here briefly sketched. As it was shown above, the mentioned operational techniques presently survive and are actually used all over the world, suitable for different applications, with different purposes. In particular, axial analysis and visibility graph analysis appear somehow complementary, as their respective pros and cons mutually and symmetrically balance and overcome each other. The main limits of axial analysis are, in fact, its plain indifference to the two-dimensional spaces; what is obviously overcome by the visibility graph analysis. On the contrary, the main faults with VGA are its computational complexity and the lacking of any correspondence between the elements of the system (the vertices) and the physical elements of the urban grid (streets, squares, blocks, etc.). In the matter of the present research, where squares (that is bi-dimensional spaces) are concerned, the convex analysis can hence appear a suitable tool for bridging the gap between axial analysis and VGA: it is obviously bi-dimensional, from a computational view it is even easier than the axial analysis, and its single elements (the convex spaces) actually correspond to material portions of the urban grid; moreover, some of them (the fattest ones) actually correspond to the geometric entities that are generally acknowledged as urban squares. The convex analysis can hence be preciously used in order to determine the non-local configurational properties pointed out above, so as to describe the relational features of the spaces with respect to the whole grid; the local features will then be observed by visibility graph analysis, thus completing at a local scale the configurational state of the selected convex spaces.

4 CASE STUDIES

The method sketched above was applied onto a wide set of urban squares, over twenty cases selected among the most interesting and renowned Italian ones. The short selection that will be briefly presented in this paper goes from ideal cases to real ones. With reference to the matter of urban squares, in fact, an interesting starting point is represented by the well known Renaissance ideal cities respectively drawn by Giorgio Vasari, Bonaiuto Lorini and Vincenzo Scamozzi, here assembled in figure 2.

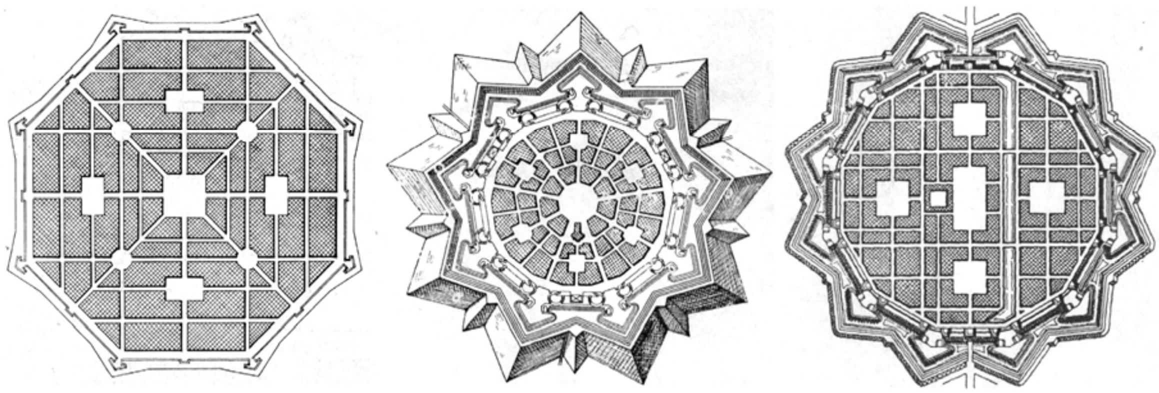

Fig. 2. Ideal cities of the Renaissance: G. Vasari (1570), B. Lorini (1609), V. Scamozzi (1612)

Apart from chronology (all worked out at the turn of the 17th century), those plans share our issue as a key theme, with a main square right in the geometric centre of the settlement and several other squares variously scattered around; their scheme makes hence them ideal cases as referred to the matter of squares. Proceeding from ideal to real, a good intermediate point is Grammichele, planned and actually built in Eastern Sicily after the earthquake of 1693; and also in this case the presence of a clear hierarchy of squares makes it an excellent testing ground of the proposed method.

The further case study is utterly real: it is Siena, whose Middle Age settlement is characterized by the presence of several different squares; among them, the outstanding Piazza del Campo, whose analysis can conveniently conclude the present discussion. The output of the convex analysis of the three ideal cities is here reported in figure 3, showing the distribution of connectivity (a), choice (b), global integration (c) and radius 3 integration (d). Figure 4 then represents the distribution of neighborhood size (a) and clustering coefficient (b) as it results from VGA. In both figures, the chromatic representation uses warm tones for high values and cold colours for low values of the indices.

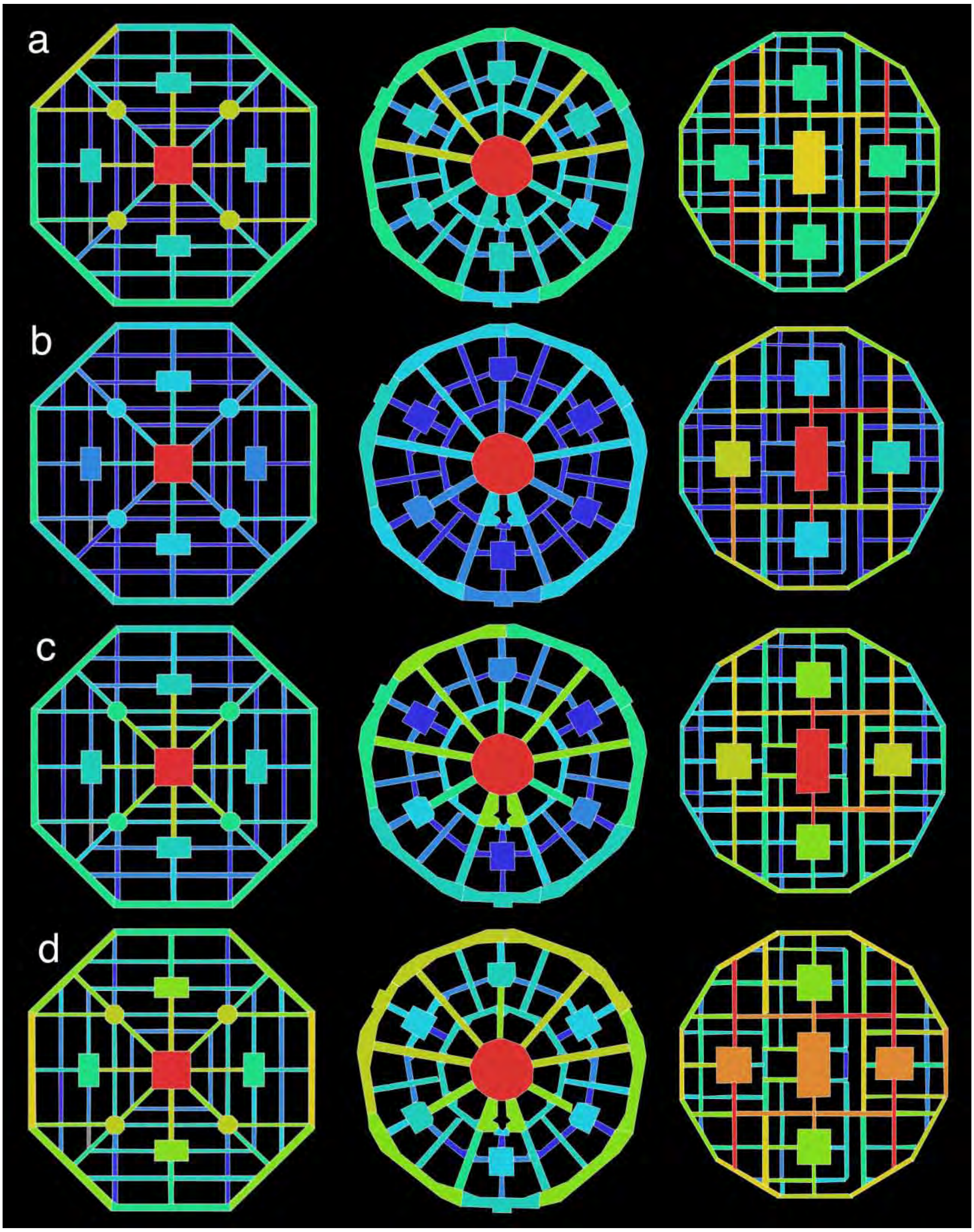

Fig. 3. Distribution of connectivity (a), choice (b), integration (c) and radius 3 integration (d) in the convex maps of the ideal cities of fig.2

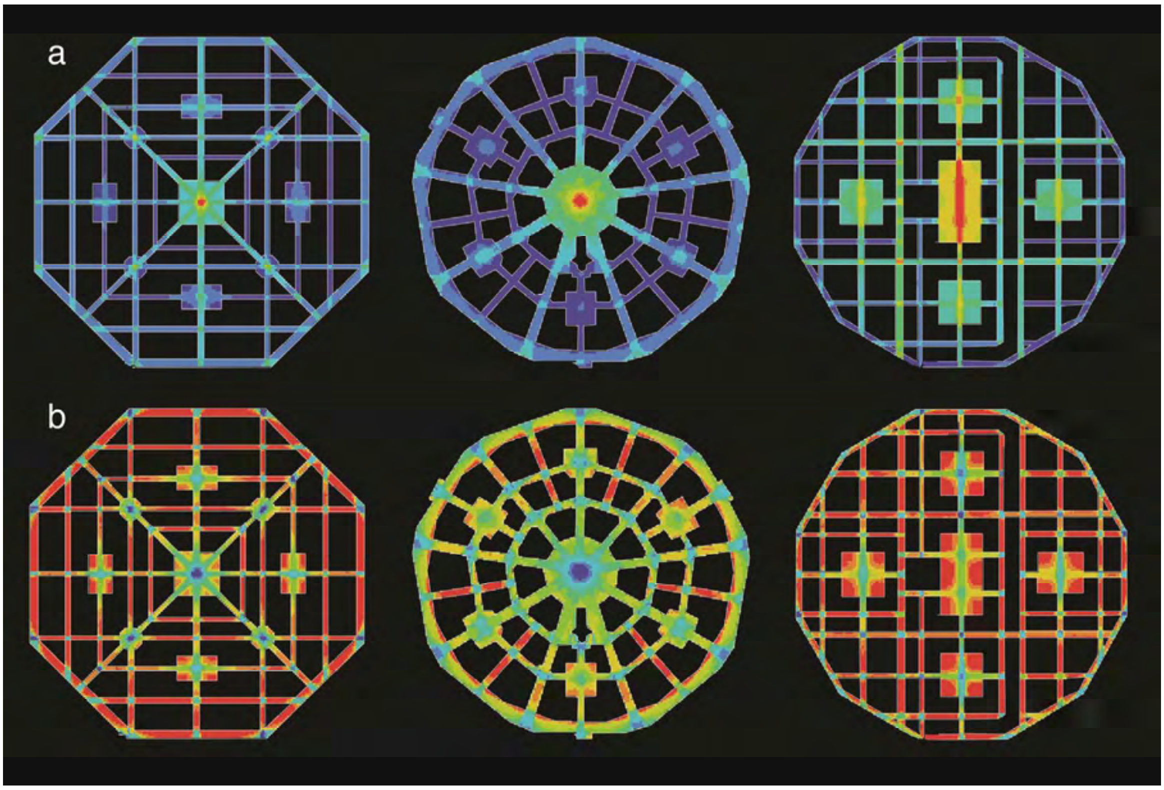

Fig. 4. Distribution of neighbourhood size (a) and clustering coefficient (b) in the visibility graphs of the ideal cities of fig. 2

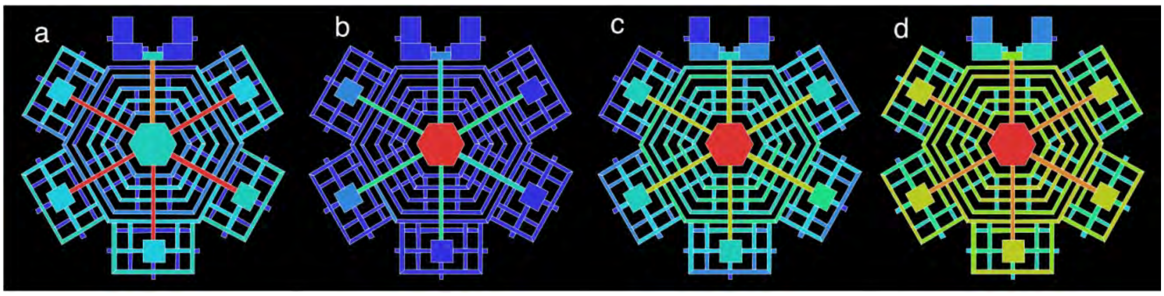

Fig. 5. Distribution of connectivity (a), choice (b), global integration (c) and radius 3 integration (d) in the urban grid of Grammichele

The output of the convex analysis and VGA of Grammichele is here reported in figures 5 and 6, which respectively show the distribution of connectivity (a), choice (b), global integration (c) and radius 3 integration (d), as well as the distribution of neighbourhood size (a) and clustering coefficient (b) resulting from the VGA of the same grids. The results so far appear to reproduce a clear hierarchy of open spaces: a central square, which is central as located into the barycentre and because of its prominent global integration and choice values (in intense red in the maps of figures 3 and 5), surrounded by local squares, to be said local in that globally poorly integrated but provided by good values of radius 3 integration. Such values do actually characterize both the three Renaissance ideal cities (fig. 3) and the real settlement of Grammichele (fig. 5). For what concerns the local properties of those squares, significant values of neighbourhood size and clustering coefficient appear to characterize them (fig. 6), even though the large number of connections squares do request cannot but penalize the clustering coefficient of many vertices of theirs. It could be intriguing to notice that the question of the difficult suiting of connection and enclosure was widely faced and discussed by Camillo Sitte, who proposed and exemplified several morphologic solutions in order to make those two conflicting aspects to co-exist and match (Sitte, 1889).

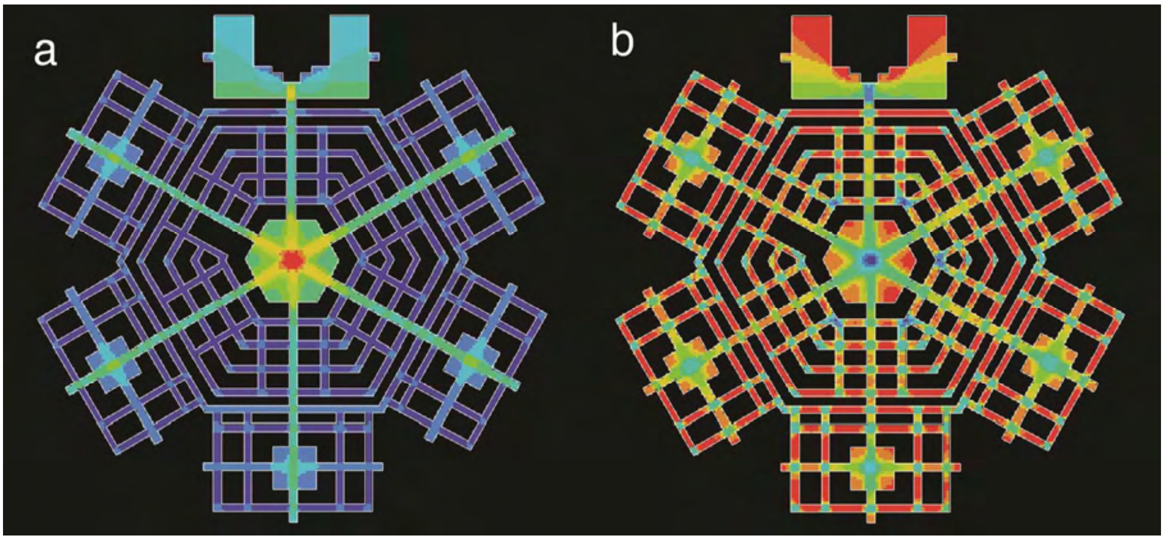

Fig. 6. Distribution of neighbourhood size (a) and clustering coefficient (b) in the urban grid of Grammichele

The configurational analysis of Siena corroborates and extends the findings above. Again a main global square is here highlighted (fig. 7) by integration, choice and connectivity values, pointing out Piazza del Campo as the very central square of the settlement; again only clustering coefficient appears to weaken (fig. 8), due to the large presence of connections the square is provided with. Also in Siena, several secondary squares appear scattered all over the grid, all provided with significant values of radius 3 integration, neighborhood size and clustering coefficient, which attest their relevance as meeting places at a local scale. In order to highlight this features, the table 1 reports the ratio v of the choice value of Piazza del Campo and the maximum frequency it would present, if it were located on all the shortest paths between any couple of the other lines of the system, compared with the main squares of the ideal cities of fig. 2: Piazza del Campo stands on over the 80% of the shortest paths connecting any couple of the other convex spaces of Siena.

	Vasari	Lorini	Scamozzi	Siena
C_h = choice value	2344	1907	1782	40418
N = nr. convex spaces	89	67	102	316
$v = C_h / N(N-1)/2$	0.60	0.83	0.35	0.81

Table 1. Choice values of the main squares

5 CONCLUSIONS

The results above can be briefly summarized as follows. The selected configurational indices appear suitable to reproduce significant features of wide urban spaces, making hence possible to work out a sort of taxonomy of the convex spaces with regard to their predictable potential as urban squares. The global configurational indices provide information about the position of the element with respect to the whole urban grid, while local parameters add some information about the geometric properties of space: in concrete, integration and choice indicate how the actual (or planned) urban location of a square allows it to intercept and gather crowded movement flows, so as to favour meeting and encounter; neighbourhood size and clustering coefficient – in a way - tell us about its local geometry.

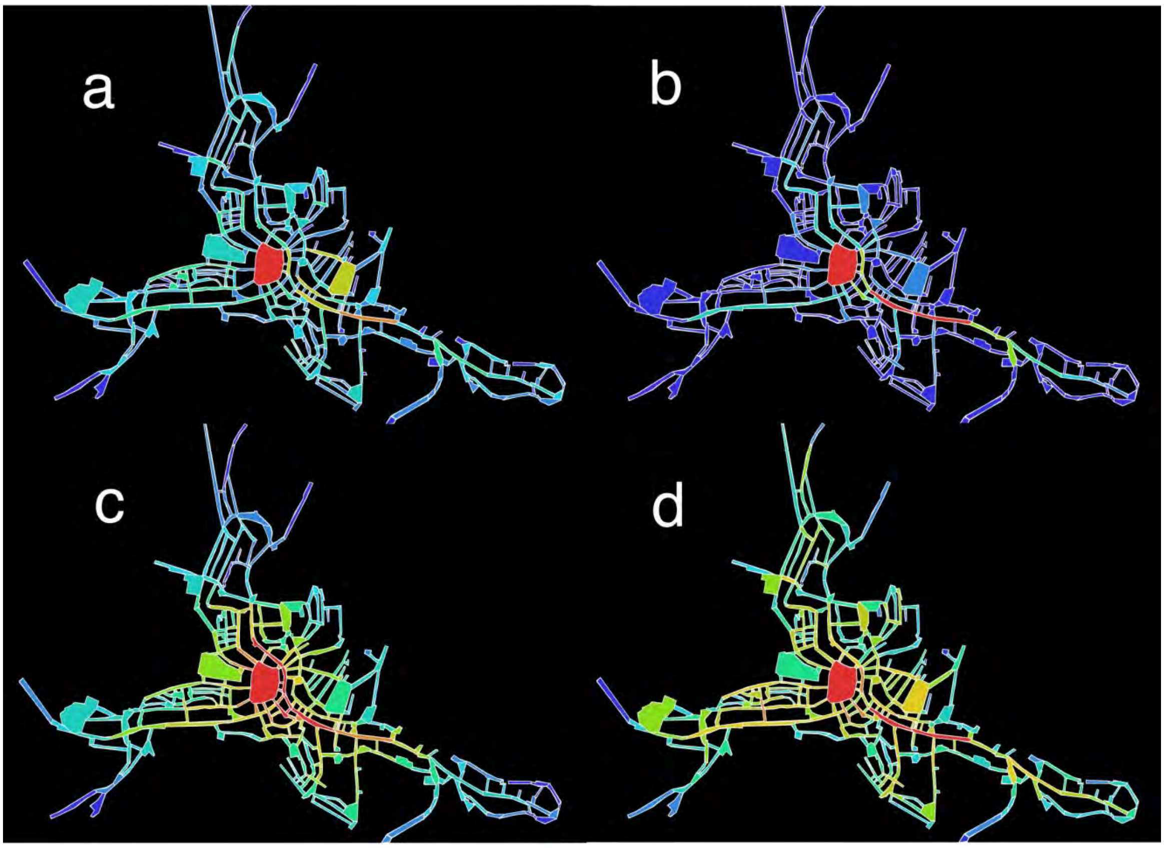

Fig. 7. Distribution of connectivity (a), choice (b), global integration (c) and radius 3 integration (d) in the urban grid of Siena

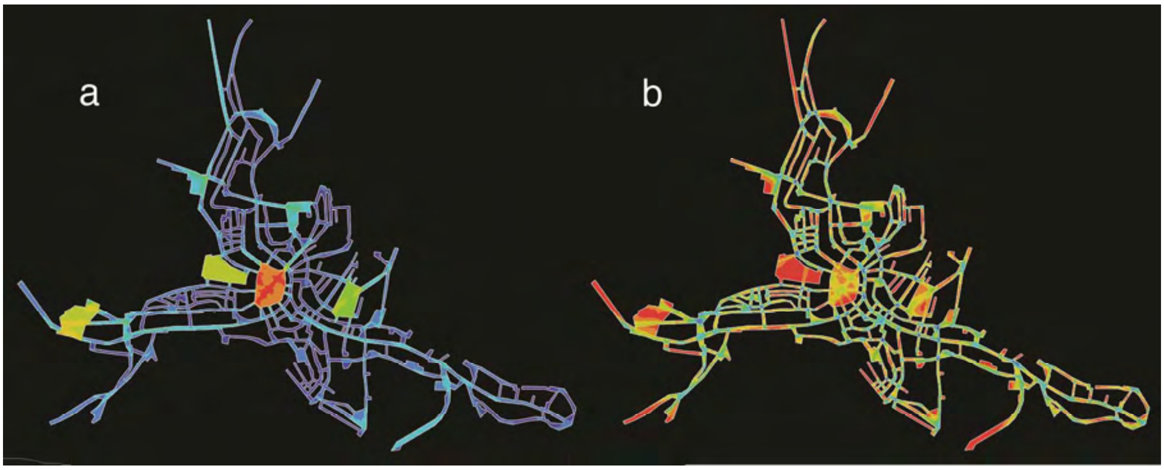

Fig. 8. Distribution of neighbourhood size (a) and clustering coefficient (b) in the urban grid of Siena

As a matter of fact, recurrent configurational values appear to characterize the convex spaces that correspond to the selected urban squares. In all the observed case studies, the main square of the settlement results provided with the highest integration value, and in most of them, also with the highest values of connectivity and choice. The mean value of neighborhood size, resulting from visibility graph analysis, again assigns those places the top of ranking, while in some cases the mean value of clustering coefficient appears to weaken, as a consequence of the large number of converging streets. Some further consideration arises from the observation of so many built urban squares, which, although designed in order to work as meeting and relation spaces, hardly appear achieving such role. On this regard, the results so far suggest that such failure results from the disregard of the configurational (both global and local) properties such a role actually requires: too fragmentary and indefinite their space, and too far and segregated from the main movement flows in term of their position. Summing up, the local properties of such places are not coherent with their functional role, nor, chiefly, coherently related. The grid of an urban settlement, as its public space, was impressively defined as “a mechanism for generating contact” (Hillier, 1996b); in this mechanism a square does hence represent the place where contact becomes encounter, meeting, interaction; that is to say, it is the natural harbour where people, moving through the urban grid, “passing each other like ships in the night” (Hillier, 1996a), finally pause, meet and gather.

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CO-CREATIVE, RE-GENERATIVE SMART CITIES

SMART CITIES AND PLANNING IN A LIVING LAB PERSPECTIVE 2

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ABSTRACT

A particularly mild approach in money supply over three decades at the international level has encouraged the piling up of substantial amounts of debt through urban investment, particularly in less competitive systems . It appears therefore necessary ato elaborate stringent "urban financial statements", through a kind of digital agenda able to provide geo-referenced economic indicators about structure, value and performance of urban capital, and therefore capable to serve as a guide in future allocative choices of the myriad of holders of some stake of the above urban capital. Recognizing the role of such a multiplicity of stakeholders means to radically reconsider the transcendent assumptions of spatial planning in favor of an immanent view of it, also suitable as reference to integrate, in a single digital guidance framework, both the above geo-referenced economic indicators and the expressions ("images") coming from the stakeholders themselves. But it also means to refer to a model of self-governance of innovation, intended as a socially driven, organic process, embedded in scalable and resilient network ecosystems. This is essentially the mandate of a Territorial Living Lab, for which nevertheless governance is itself a matter for experimentation and innovation, as well of contamination with other models, within the objective of combining capital investments in urban regeneration with the need to attain an effective yield on such investments through diffused and citizen-based ownership of the urban innovation they aim to spark off.

KEYWORDS

Urban capital, Immanence, Territorial Living Lab

1 INTRODUCTION

As position paper of the "Smart Cities and Planning in a Living Lab Perspective" session of Input 2012 we presented a paper with the same title (Concilio and DeBonis 2012), aimed at outlining first of all a viable framework for a planning approach to the topic of Smart Cities, situated at the intersection of the research on Smart Cities with the theory and practice of the so called Urban/Territorial Living Labs.
In the same year we also contributed to IFKAD-KCWS with a paper (De Bonis, Concilio, Marsh and Trapani 2012) highlighting the need of a much more deeper integration between socio-economic action and spatial planning, through the co-creative approach of Urban/Territorial Living Labs, able to focus not only on merely sectorial ICT R&D issues but rather on the transversal problems of cities and territories (Marsh 2008), in order to pursuit objectives of territorial cohesion and development, directly by socio-economic actors self-organized in "living lab" environments.
As further development of a reflection on the co-creative relationship between socio-economic sphere and urban planning we present here first of all some basic considerations about economic links among monetary policy, urbanization processes and spatial changes in a globalized urban economy, to take carefully into account in planning processes aimed at fostering urban smartness. To this end it appears both possible and necessary to elaborate stringent "urban financial statements" through the effective use of new technologies, as a kind of implementation of a digital agenda for "functional urban systems", able to provide geo-referenced economic indicators about structure, value and performance of available and optional urban capital, and therefore capable to serve as a guide in future allocative processes.
Moreover, as the above considerations about urban economic trends lead inter-alia to recognize the fundamental role played in the urban/territorial systems dynamics by a multiplicity of "stakeholders" (i.e. holders of some stake of urban/territorial capital), interacting each other through distributed and generally uncoordinated decision-making, we outline a radically immanent view of spatial planning. Such a view is also able to serve as strong reference to connect and integrate, in a single digital guidance framework, on the one hand the "expert" information layers aimed at building the above "urban financial statements", and on the other the expressions ("images") of the myriad of interacting entities in the urban/territorial context, from which the visions can emerge, able to orient and polarize, together with the mentioned statements, the multiple processes of molecular interaction.
As a possible form of governance consistent with an immanent view of planning, we hereinafter identify a "social" model of urban and territorial innovation in Living Lab environment, able to overcome the by now hackneyed dichotomy between top-down and bottom-up approaches, in that it is scalable and adaptable to different, appropriate levels of competence, including the institutional ones.
Finally, we illustrate some interpretations, convergent but not necessarily coincident, of the nature and the role that the above kinds of Living Lab environments could play in the dynamics of urban and territorial development.

2. SMART CITY AS CAPITAL ALLOCATION INSTRUMENT

The patterns of transformation of urban systems over the past decades seems to have been influenced by monetary policy, with global urbanization being fuelled, to a large extent, by low interest-rates environment prevailing at the international level.
A particularly mild approach in money supply over three decades has delayed a debate on the rationalization of urban capital stock accumulation, particularly in less competitive systems. These, thanks to the

continuous expansion of financial markets and easy money, have benefited from a growing capacity to pile up substantial amounts of debt, before being confronted with the need to enforce fiscal correction policies aimed at ensuring the systems' financial long term sustainability and avoiding painful municipal debt restructuring.

As a result of these monetary policy trends, urban investment - normally having a Keynesian "pull" role to stabilize the economic cycle during recessions – has assumed a "push" pro-cyclical economic mission, with urbanization processes being considered as an economic modernization objective "in their own merit".

A further potentially important, but often unnoticed, spatial effect produced by loose monetary policies seems to be the following: in a monetary union (and overall in the globalized economy) interest rates determine an acceleration of factor mobility and resource transfers from urban systems characterized by relative low productivity and higher (risk-factored) cost of capital towards those system which are enjoying an (often allegedly) higher productivity, employment conditions and relative lower cost of capital (Leanza and Carbonaro 2013).

As a result of the growing impact of globalization correct investment strategies, urban financial performance and appropriate funding of investment, play a relevant role as a constraint (or boost) factor in shaping cities. The economics of single projects/firms (and even production factors) will increasingly be assessed with reference to the overall competitive structure/trends and overall financial features of the systems to which they belong (Moretti 2012).

In urban areas – considered as dense job systems according to OECD (2009) - the performance of the a) human capital factor is deeply bundled with other four types of interconnected productive factors, namely: b) natural resources; c) housing, productive, logistic and infrastructure assets; d) financial capital; as well as e) economically relevant "land and spatial factors".

Urban systems – intended as above – are therefore characterized by a multiplicity of active operators (families and individuals, but also public sector, private enterprises, working unions, as well as not-for-profit entities, and legal entities) which interact through distributed and generally uncoordinated decision-making processes. Interestingly enough, urban stakeholders (as such as a normal citizen or a family located in the city) are potentially carriers of the five types of capital described above.

The lack of a well-defined, pyramidal control chain in an urban system does not preclude the possibility for the authorities to draw pro-form financial statements representing its consolidated structure and performance. Urban financial statements, accompanied by urban econometric models would cover areas with very large populations, above-average revenue-generating capacity and overall financial/taxation base.

In EU large economies, the launch of an innovative digital agenda program (spatially-customized to cover the features of the metropolitan job systems) can help understanding the "true economic performance" or structural indicators of metropolitan or large urban entities and drive the future economic recovery of most ailing systems through better capital-allocative processes.

This element appears to be a prerequisite for the realization of any successful smart city strategy based on capital allocation optimization and a strict financial discipline. The risk is a misallocation of urban capital and over-investment towards city systems which are "spatially" misplaced or obsolescent, therefore conducive to the destruction in the long term of valuable economic and financial resources.

The smart growth process requires a reassessment of the economic role and performance of the majority of the urban players, which represent a major share of the invested capital and debentures as well as of land holdings at city's scale.

The complexity of these processes will require innovative and "smarter" forms of city governance, organisation and controls in order to ensure an effective allocation of scarce capital resources to different urban systems, in order to maximize the productivity and efficiency of investments and the overall capital accumulation processes.

The smart city approach may result particularly useful in order to tackle the issue of "value creation" and of a correct "capital allocation" in urban systems facing a rapid evolution of their competitive environment. In particular, based on a value creation approach, a stronger emphasis should be attributed in the future to the capacity of the single metropolitan/urban areas to generate sustainable long term wealth growth (as compared to other types of more traditional indicators, as GDP).

By applying such an approach, researchers are confronted with an important issue: urban stakeholders and, more generally, individual urban systems (which remain highly differentiated in terms of: assets/liabilities structure and net debt/credit position) are supposed to be driven mostly by the ambition to increase the cumulative amount of wealth (or value) enjoyed by their stakeholders and citizens. This result would be achieved by maximizing the long-term return (i.e. the sum of "organic" and "speculative" components) on urban net worth (net of financial debentures and other liabilities).

The short-term perspective of most of the urban stakeholders' efforts and the overlapping of many uncoordinated objectives, actions, measures, approaches of the urban players, however, render particularly complex the achievement of the above-mentioned purpose due to lack of coherent approaches and information. The preparation of urban financial statements representing the five types of capital mentioned above and the accurate collection of critical data and information through the digital agenda appear as necessary steps to prepare diagnostic and prognostic scenarios which enable the public sector operators to operate forecasts on the likely evolution of the urban systems economies.

This information is necessary to facilitate the taking of correct investment decisions by urban stakeholders. In this context, a renewed investment in the "smart city" concept, can represent an important and effective "second best" capital allocation device, in order to compensate the lack of discipline and direction normally provided by the activity of central banks in an orthodox monetary context.

3. IMMANENCE, TERRITORIAL INNOVATION AND SPATIAL PLANNING

The interaction, multiple and dynamic as well potentially and co-creatively innovative, among a variety of urban and territorial stakeholders (i.e. holders of some stakes of urban/territorial capital), is fundamentally characterized by its social (and environmental) immanence. As such it necessarily requires a radical reconsideration of the assumptions implicit in most of theories and practices of spatial planning, conversely historically prone to transcendence, like indeed many other social and design sciences (Bateson 1972a; De Bonis 1999).

To retrieve an immanent horizon in planning research we can however refer to a relatively recent contribution of J. Hillier[1] (2005), in which she first of all recognize that «Faced with conflicting and seemingly incommensurable decisional imperatives, organizations are under constant pressure to adapt or transform creatively» (Hillier 2005, 272). More generally, i.e. referring not only to "conflicting and incommensurable decisional imperatives" and to "organizations", we could say that the creative transformation (innovation) should always be thought as emerging from the interaction internal (immanent) to the some kind of "self"-individual, infra-individual (part of the self) or inter-individual/trans-human (the social self and

1 On this topic see also the contributions of De Bonis (1999, 2001), essentially based on the philosophical approach of P. Lévy (1994, 1995) to the general question of the immanence.

environmental), rather than separate instances and higher (transcendent), since there is no other chance to "adapt themselves".

On the contrary, «As planning theorists and practitioners we seem to have had a pervasive commitment to an ontology of being which privileges end-states and outcomes, rather than an ontology of becoming which emphasizes movement, process and emergence». Nevertheless, such a commitment «... may begin to be dissolved by referring to Deleuze and Guattari's concept of "becoming", in which ideas do not come to order from abstract and/or external notions, but develop as part of practical, creative experimentation played out within and between economic and socio-political institutions» (Hillier 2005, 273).

With specific reference to the Deleuze-Guattari's key principle of "movement or change, immanence" Hillier also points out that in such a thought the "becoming" is bound «... to the unpredictable, indeterminate, never-accomplished actualization of virtualities» (Hillier 2005, 281). This also means that the change «... incorporates "traces" of its genealogical past, which both constrain and also create potential opportunities for the future» (Hillier 2005, 280). The conclusion is that «Planning's role is to make the virtual intelligible» (Hillier 2005, 281), but perhaps we should say, with Levy (1994), that it is rather a question to make sensible the purely intelligible, letting this latter pass through the bodies and the behaviors. And we could also maintain that the "actual", intended as the creative and not predeterminable outcome of a virtual meant in turn as a potential (Levy 1995), is implied and must be sought in the folds of the real, rather than in its utopian rejection, so typical of many planning theories and practices.

The waiver of any transcendental rationality is recognized by Mäntysalo, Balducci and Kangasoja (2011) in the (uncertain) revival of Lindblom's partisan mutual adjustment (PMA), which occurred with the advent of the theory of agonistic planning (Mouffe 1999, 2005). According to the authors, an essential complement of this latter in the direction of a revaluation of Lindblom's PMA, it is the "trading zone" approach (TZ), particularly in the declension ("trading with the enemy") of P. Galison (2010).

We leave now aside an explanation of why we do not consider the approach TZ/PMA complementary to the agonistic one[2], but rather potentially alternative and also more productive, to underline that, according to Mäntysalo et al. (2011, 267), the main contribution of Galison's TZ consists essentially in placing at the very center of attention, or rather of trading, the frameworks of exchange between the different systems of meaning of which the "enemies" are bearer rather than the systems themselves. Frameworks able as such to promote locally coordinated interactions even between enemies (or at least adversaries[3]), which may therefore be particularly pertinent also for "local" (or localized) planning practices, similarly interpretable as "exchange languages" through which "thin descriptions" of ideas, proposals and opinions can be communicated between different groups.

In this regard the cited authors point out - and we believe this is a fundamental notation - that the physical nature of the object of planning, i.e. its nature of place that connects the various stakeholders precisely as each of them "holds" a stake (Healey 1997)[4], is a crucial component of this trading zone of planning.

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2 For a slightly more in-depth critique of the agonistic theory see De Bonis (2013).

3 According to Mouffe (1999, 755) it can be said that the aim of democratic politics is precisely to transform antagonism between enemies into agonism between adversaries, this latter to be therefore considered as "legitimate enemies".

4 Let us note that it is not even necessary, for that purpose, to materially "hold" a stake of physical space if this latter is interpreted as a non-linguistic means of communication (medium), interconnecting anyway the different "urban entities", independently from the linguistic meanings (and "values") attributed to it by the same entities (McLuhan 1964; De Bonis 2001, 2009).

Nevertheless, it is worth highlighting that Galison's approach ("trading with the enemy"), to which Mäntysalo *et al.* (2011) refer, could be reformulated in much more general terms than those strictly related to an "enemy" (and "adversary" as well); as it could be assimilated to the conditions of contexts, by now inevitably "intercultural" although not necessarily multiethnic, in which planning processes ordinarily take place Bateson 1972b; De Bonis 2004). Moreover, taking into account the theory of Trading Zones – and assimilating these latter to physical spaces - implies in our view the recognizing of the residual role, although not needless, of professional planners and institutional policy makers in the making of (urban/territorial) policies (Lindblom 1990; Crosta 1998).
A residual but not useless role that can be precisely associated with those exchange frameworks, to better interpret in our opinion as media rather than languages (McLuhan 1964). And through which, anyway, they could inter alia be integrated and connected both the "expert" information layers aimed at building the above "urban financial statements" (see par. 2), and the expressions ("images") of the myriad of interacting entities in the urban/territorial context. Images from which, eventually, some visions can emerge able to orient and polarize, together with the mentioned statements, the multiple processes of molecular interaction (Lévy 1994; De Bonis 2009).

4. LIVING LABS AND MODELS OF INNOVATION GOVERNANCE

European policy is currently undergoing a significant transformation from an emphasis on the "knowledge economy" and competitiveness to an approach in which innovation is the driving force for achieving social and territorial cohesion in a "smart, sustainable, and inclusive" society. In this metamorphosis from an essentially sector policy (research) to a transversal policy (societal transformation), innovation itself takes on a deeply spatial dimension. If technological innovation is based on research facilities and knowledge capital, non-technical, institutional, and social forms of innovation are based more on territorial capital (in the broadest sense), and their processes and outcomes are far more a function of territorial specificities.
In this context, the Living Lab model emerges as an operational framework for the governance of such territorial innovation processes, having itself undergone a significant transformation. Born in 2006 as a user-driven research methodology in Information and Communications Technologies (ICT), notably for mobile (now 'smartphone') applications, the Living Lab co-design approach has grown and developed through a range of variations in different settings. The methodology has thus been applied in universities (to promote student engagement), rural community action groups (to strengthen local development with technology innovation) and, more recently, as a tool for local and regional policy. This latter model, often referred to as a Territorial Living Lab, aims to promote territorial innovation as a shared objective in the public interest, capable of generating initiatives that both increase the yield on territorial capital and increase citizen well-being and quality of life as a result of engaging all stakeholders in co-designed innovation processes of value creation.
As Living Labs assume a quasi-institutional framework for the experimentation of new approaches to leveraging urban and territorial capital, transcending the episodic nature of bottom-up initiatives, the issue of governance emerges as a key for guaranteeing the sustainability of territorial innovation processes. From a Living Lab perspective, the rules and processes of governance itself can be seen as situated in a dialectic driven by differing stakeholder perspectives. In regional policy, this translates into the structural conflict between the need to monitor and control the use of public money on the one hand, as against the need to guarantee the openness and creativity of emergent innovation processes on the other.

This "trading zone" can essentially be seen to negotiate between three governance concepts related to territorial innovation. The first 'techno-commercial' model focuses on innovation as the development of new products and services in a logic of efficiency as applied to market dynamics, standards formation, common methodologies and best practice, using rules and regulations, fiscal incentives or direct financing of research as the main policy instruments. This is primarily a top-down approach typical of industrial policy, as reflected in many EU and regional research policies and agendas. The second 'politico-institutional' model focuses on more ethical and spatial policy objectives, such as transparency, fairness, inclusion and cohesion, aiming to influence strategic policy processes in a multi-level model in which innovation is linked to the bottom-up approach. The third 'socio-emergent' model, derived from the Open Source movement, the 'hacker ethic', and emergent self-governance principles, holds innovation as a socially driven, organic process that becomes an ethical principle in itself, with governance embedded in scalable and resilient network ecosystems.

While these three governance models generally consider themselves to be mutually exclusive, the new policy approaches – for instance by requiring to include social innovation in regional innovation policies – leave little choice but to work towards a reconciliation (even a 'partisan mutual adjustment'). This is essentially the mandate of a Territorial Living Lab, for which governance is itself a matter for experimentation and innovation, within the objective of combining capital investments in urban regeneration with the need to attain an effective yield on such investments through diffused and citizen-based ownership of the urban innovation they aim to spark off.

5. TERRITORIAL LIVING LABS FOR URBAN REGENERATION

The trend towards spatial interdependence between the places of production of goods and those in which entrepreneurial ideas and social demand are formed has a significant impact on settlement trends in our urban-territorial systems. Economic production is changing shape to address and overcome the crisis, while the social systems are left alone to assure the survival of welfare and quality of life. The delay in any effective political response to these deep structural changes taking place is by now threatening the very political cohesion of the European Union. The different dimensions of community, city, territory, region, Member State, and European Union are by now separate and increasingly distant levels. Government action is inadequate to address the fragmentation caused by positive and negative effects of transformation in the modes of production, the lack of any connection between entrepreneurial activity and economic policies, and company failures that seem to have no effect on natural selection while simply leading to a desertification of prospects of employment. It thus becomes urgently necessary to experiment new methods and above all development policies that abandon the ambition of guiding social, economic, cultural and environmental change, instead building on concrete examples of successful interactions and dynamics in both the socio-economic and the spatial-infrastructural dimensions.

Living Labs, considered as effective ecosystems of agents interacting co-creatively, appear poised to constitute a useful reference for the multi-scalar integration of levels of governance. The diffusion of basic ICT technologies and services in ever-broader spectrums of the population, despite the ample margins for improvement of the web, is transforming the potential of self-organisation. The act of sharing a problem statement or entrepreneurial idea is today the starting point for building a start-up company or community of interest capable of reaching important objectives independently of any institutional support. These processes are born of dialogue more than physical proximity, addressing more or less severe issues of survival or job creation in a process of mutual support. The net is a space to raise issues, search for solutions, find someone to listen, and build together a common initiative that satisfies and convinces the different stakeholders involved. These simple communities do not need to make any social or political claims in that their requests for support are not directed towards institutions but rather to the consensus of the broader arena of the social networks. Only in a second phase do the institutions step in, providing support and promoting the contribution of external private capital.

The space of social interaction thus extends from the traditional public spaces of streets, square and public buildings to the relational dimension of communication. What is at first a cloud of ideas and visions is driven by a collective tension towards real action, changing a negative situation or grasping an opportunity based on the forces present at a given moment in a given urban space. These urban transformations are quite different from the disruptive transformations caused by heavy investments in grand projects led by local or global funds. Compared to these projects, which in the space of a few years radically change the urban landscape with skyscrapers and immense containers of technology, the transformations of urban spaces brought on by Living Labs appear nearly invisible. Differently from the Business Centres, Olympics, World Cups, and Expos, however, Living Labs are proving capable of acting positively on the connective social fabric of a city, despite their fragmentation and their almost random urban-territorial distribution, far from the grand designs of governments and agencies (far then from urban planning). Above all, they are socially effective despite the apparent lack of resources (far from economic programming).

It is early to interpret and predict what the potential impact on urban and territorial systems would be if institutional planning and programming were capable of fully integrating the Living Lab approach. It is nonetheless important to reflect on the possible relations between these two heterogeneous dimensions: on the one hand the goals and actions of institutional programmes and on the other the spontaneous and unpredictable rise of ecosystems that freely generate co-creation.

6. SPACE_BASED INNOVATION IN THE CITIES

The stories collected by Jeffrey Hou (2010) offer a clear understanding of the ways in which the current social, political, economic and cultural challenges are faced in the city, by the cities; these ways are no longer simple spaces (physical or not) of contestation rather they are " insurgents" activities that, through self-produced spaces, temporary events, or even flash mobs, can trigger long-term dynamics of transformations. They are spontaneous processes with relevant potentials for radical changes; many of them are planned by a collective will that, being difficult to analyse, is characterized by self-awareness and therefore is able to be transformed into action.

The dynamics we are observing in many urban realities confirm the existence of important innovation energies. These energies are manifested mostly at the sub-urban scales, neighbourhood or perhaps even more micro scales; it seems to be associated to a collective, spatialized, and localized will, that is unable to distinguish between the private and the collective or better able to integrate private and collective within a broad vision of "citizenship making". At these scales a new way of making the city is emerging: the city is not designed, it is rather experimented; the city is not a service offered to citizens, it is rather created by the citizens through place making experiments; the city is able to give life to bottom -linked institutions (Moulaert 2010) that can sew , and densify, the relationships between citizens and governments; the city is created through the activation of areas in which the rules can be temporarily suspended and new ways of "city making" can be experienced (these are areas of Utopias Temporaire).

The identification of some common characteristics of such (sub)urban innovation processes helps us to refine the concept of Urban Living Lab. Urban Living labs are environments in which innovation is spatialized, i.e. it is generated within a specific spatial environment (not necessarily "for" this specific environment, although in many cases the improvement of the context is the main aim of the initiative). The scale of these environments is smaller than the urban scale; nevertheless they are able to draw prospects for systemic changes at the scale of the city; often, in fact, they have viral effects that move innovation from the micro-urban scale to the larger city. These are environments in which the openness of innovation manages to transcend the organizational infrastructures that are traditionally operating in the city and to invent new institutional figures for, or ways of, dialoguing between citizens and institutions. Here openness is enhanced by a dynamic nature that is revealed through new forms of temporary partnerships (public-private or public-private-citizens) that, rather than being based on formal agreements, are embedded, hinged in the action: the action becomes the measure of mutual commitment, temporary or long-term, that each actor can guarantee. Yet, in these environments, the openness guarantees experimental approaches that can range from small practices intervening in the city to the experiment-based development of urban transformation policies. Finally, in these Urban Living Lab technologies can play different roles; unlike in the original concept of Living Lab, technologies can be not simply drivers of innovation but also (and perhaps especially) tools that enable or means capable of activating the energies of innovation that are embedded the city.

In many ULLs, it is possible to observe that public administrations are involved in many different ways: they are asked to approve, support, or collaborate actively and their involvement varies from very light engagement (for example, in those cases where their role is limited to sponsor some initiatives) up to deep responsibilities assumed with important resource investment and even complex public decisions.

While local public adiminstrations' role is easy to recognize inside the Urban Living Lab environments, it is not equally easy to understand whether, and to what extent, they look at the Urban Living lab experiences as important contribution to the development of the urban smartness. In most cases it appears that there is no-institutional awareness into this direction; this lack of awareness may depend on their small scale; still, it may also emerge from the distance of many of these initiatives from the most spread concept of urban smartness.

The many challenges that local administrations are called upon to deal with are increasingly highlighting the need and importance for the city to activate, attract, manage, and support innovation. How to strengthen, or better, to develop the innovation capacity of a city towards an "integrated" smartness? Louis Albrechts (2013) recently reiterated: "More of the same is not enough!" In addition to this awareness it is clear that no isolated answer or solution, whatever bright and/or general it may appear, is enough; this also suggests that the sub-urban scale of living labs is the one in which the skills and energies of innovation should be fostered, activated, incurred. It is at this scale that it seems possible for the city to experience multiple, different smart solutions. It would seem, therefore , that the most significant challenge for local governments is precisely to be able to look at the city as a large, however complex, experimental laboratory to which every living lab contributes.

A perspective of management and governance of a smart city based on experiments implies in practice at least three areas in which the action of local governments needs to be rethought: 1) the regulations, 2) the policies and 3) the forms of agreement with citizens and private actors. Many activities in the space of the city are governed by a system of rules that in many cases do not appear adequate to guarantee the life to some of the forms of innovation towards smartness; these forms of innovation have started rooting in the cities although somehow violating rules and regulations. Without compromising the value of social and collective rules, public authorities have to find out how to develop new rules, or forms of rules, that are able to consider the legitimacy, at least temporarily (consistent with the experimental perspective), of ways and forms of action in the city, ways and forms unusual until today.

The reflection on the rules does not differ much from the one that we can start on urban management and transformation policies; it obviously becomes more complex due to the link, which often policies build with values systems. An experimental nature of policy-making requires a significant integration of the focuses: the policy object and the policy process, the policy goals and the policy making. This perspective was already evident in the reflections of Pierluigi Crosta (2006), but it is now enhanced with a strategic significance of "value creation" that goes beyond the more usual perspective, sometimes prevailing, of "values guaranty”. The perspective of experimenting at both the level of regulation and that of policy-making inexorably imposes a rethinking of the ways to manage and deal with the relationships between governments, citizens and private actors.

Many formal devices are already available that substantiate different ways of interaction and agreement between different subjects and this somehow helps; some experiences, however, have shown that when the interaction between these subjects happens in a experimental environment, a lower degree of agreements formalization is preferred. When there is a low level of formalization the responsibility mechanism is no longer guaranteed. Therefore it is necessary to imagine new models of "responsibility" of action in the public sphere that does not mortify innovation initiatives such as those emerging in the cities.

The challenges facing local governments can all be summed up in one question: how can the government take advantage of the learning opportunities offered for the urban scale by the numerous smart, innovatiion initiatives that are not at all limited in their potentials by their non-urban scale? A city that is smart, or able to innovate, is a city capable of civic intelligence (Schuler 2013) i.e. a city capable of experimenting and then learn collectively and it is in this direction that local governments needs to rethink their role towards smart cities.

7. CONCLUSIONS

Whether with reference to an immanent view of planning and highlighting or to the links between monetary policy and spatial transformations resulting from urbanization produced by the global dynamics, it is easy to recognize the fundamental role played in the evolution of urban and territorial systems by a multiplicity of stakeholders interacting within distributed and generally uncoordinated processes.

The residual action of experts and public administrations should then focus on: i) defining some useful orientation frameworks aimed at enabling the aforementioned stakeholders to take appropriate decisions in terms of creation of urban well-being in the long term; ii) finding the suitable forms of interrelation, outside of any claim of exogenous control, with socio-economic entities related to the phenomena of co-creative innovation, such as the so-called Urban/Territorial Living Labs.

In both cases, it is not only to offer contributions to the coordination of socio-economic actions and of co-creative ferments, but also to overcome urban policies based on the one hand on economic policies of Keynesian-Fordist kind, potentially generating strong socio-economic instability, and on the other on transcendent conceptions of planning, by now unable to grasp the complexity of the co-construction processes of the contemporary urban phenomenon.

NOTES

Although the paper is the result of the joint work of the authors, L. De Bonis wrote sections 1, 3 and 7, E. Leanza section 2, J. Marsh section 4, F. Trapani section 5 and G. Concilio section 6.

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THE MODEL OF VORONOI'S POLYGONS AND DENSITY:

DIAGNOSIS OF SPATIAL DISTRIBUTION OF EDUCATION SERVICES OF EJA IN DIVINÓPOLIS, MINAS GERAIS, BRAZIL.

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ABSTRACT

This paper represents the application of a methodology that supports urban environmental studies to the identification and mapping of areas of influential points or spatial phenomenal occurrences, using the techniques of Multicriterial Analysis and of Voronoi Polygon. It focuses on the use of institutional alphanumeric database transformed into spatial analysis by the use of GIS and models of distribution, to support decision-making regarding allocation strategies and expansion of centers of experimental education called "EJA" (Youth and Adults Education) in Divinópolis, a city in the state of Minas Gerais, Brazil. It describes the process of data that composes information which makes possible to perform urban analyzes and to simulate the scenarios considering the expansion of the system and the review of the allocation of some points.

KEYWORDS

Voronoi Polygon, Multicriterial Analysis, Urban Services Distribution, Spatial Analysis

1 INTRODUCTION

Tools to represent spatial distribution of phenomenon and to analyze the influence of urban entities and occurrences in specific area will be each day more necessary for administrators. The municipal administration is approaching more and more the logic of business. This fact requires increasingly responsible policymaking, reasoned and strategic. In this context, the application of decision support methodologies in urban environmental studies and the identification and mapping of territorial influence of services, represented in punctual spatial occurrences of phenomena, are fundamental to define zoning and administrative segmentations of a territory.

The administration in Divinópolis faces the difficulty of adopting decisions regarding to opening new schools with the Experimental Project EJA (Youth and Adults). To deal with that this study developed a methodology based on Multicriterial Analysis and Voronoi Polygon, in order to give support to such decisions.

According to Moura (2009):

> *The Multicriteria Analysis is a methodological procedure for crossing variables widely accepted in the spatial analysis. It is also known as a result of Decision Tree or Hierarchical Analysis of Weights. The procedure is based on mapping of variables on matrix representation and the definition of the relevance of each variable and each component of the legend to build the final result. The mathematics employed is the simple weighted average and some researchers use fuzzy logic to assign the weights and grades. The Voronoi polygon is an analytical model that allows the studying of areas of influence, from defined locations, considering their relative positions to dataset. The principle is that areas of influence are not composed by simple Euclidean distribution, but are deformed by environmental friction (for example, barriers to urban expansion) and by the mass of its generating points (eg , number of students or vacancies in the schools) .*

1.1 THE CONCEPTUAL BASIS OF THE APPLIED MODELS

A) MULTICRITERIA ANALYSIS

The Multicriteria Analysis had popularized significantly among GIS users, being the model of spatial analysis more used when the objective is the construction of diagnostic and prognostic of a territory, in different scales and with different objectives. There are two reasons for this wide dissemination of the model: the clarity in translating the objectives based on logical analysis in the structuring of the model, and the existence of tools in geoprocessing software, which even if they don´t present the whole model itself, they permit to build the steps needed to the process.

The Multicriteria Analysis can be translated as an algebra of maps, which favors that a problem is subdivided into its main components - the variables that interfere in their behavior - and that they are integrated and combined in order to build a system.

The idea of Multicriteria is not new. It began with Systemic Approach, in the 1950s, from the investigations of the biologist Ludwig von Bertalanffy (1975) who proposed the interdisciplinary studies according to the General Theory of Systems. The reality is seen as juxtaposition and interposition of parties composing a system in which the variables are interdependent and any change results in changes to the hole ensemble.

The idea of Analysis as a process is based on promoting the abstract representation of the phenomena in order to favor their explanation by models which allow their descriptions. In the 1960s, Chorley and Hagget (1967) developed studies of its application to geography, contributing to the understanding of models in spatial analysis.

It is necessary to understand that the Systemic Approach is not only the decomposition into parts and recognition of a phenomenon by its component parts, but it is, above all, the understanding that this decomposition only makes sense if the elements are analyzed in relation to the context in which they are inserted. The elements have characteristics that define them (intensity, mass, age, localization, and so one) and the values of these characteristics mean the states of the elements in a given place at a given time.

A model is the simplification of reality in such a way that it is represented by its essence, eliminating what is not significant for the characterization of the phenomenon and for the purposes of analysis. According to Chorley and Hagget (1967), the models are the formal presentation of a theory the uses the tools of logic, a set theory and mathematics. A model can be a theory, a law, a hypothesis, a structured idea, a relationship, a function, an equation, a synthesis of data or descriptions of the real world. As simplifications of reality they have as important point the selection of the most relevant aspects. The system is studied using a determined purpose, and everything that does not affect this objective is eliminated.

Huggett (1980) explains the process of structuring the model for development of systemic analysis: "By discriminating system parts of sub-systems at different levels of resolution, a complex system is simplified in a logical and realistic way which avoids the bewildering bulk of information at microscopic levels."

Through simplified models, with very initial processes, and based in the logic to decompose to compose, the first more significant application in the area of spatial analysis that followed these principles was the work of Ian MacHarg in "Design with Nature" (1969). The author presents the territory characterized by a series of thematic maps and proposes the identification of appropriate areas for different uses, including preservation and installation of anthropogenic activities. The result is a combination of thematic maps, at that time promoted by simple overlay of maps, which allowed the identification of remarkable places, resulting from the synthesis of variables that best meet the objectives of the analysis. It was the analytical process by decomposition and the synthesis by integration.

By identification of the main components of a system, they can be isolated in information plans or layers. With this ensemble of data, various professionals, with their knowledge and specific objectives, may propose different processes of integration of variables, resulting in a more dynamic interpretation of reality. The descriptions become richer, because they reflect "what", "where" and "how".

Steps on methodological process, according to Moura (2003):

- definition of objectives and applications in the use of the system;
- organization of alphanumeric database and mapping;
- treatment of data for raster analysis and as representation of potential distribution of phenomenon;
- definition of weights and values of the variables;
- integration of the variables in the analysis of multi;
- comparison with the existing reality;
- system calibration and return to the stage of the analysis;
- construction of scenarios (if/then);
- drawing up proposals for intervention, management and restrictions.

According to Anselin (1999) there are steps of understanding the problem, with exploratory analysis, which aims to understand more about the object investigated; and there are steps based on structuring the system and constructing models that represents the reality. Because of these procedures Multicriteria Analysis works, really, as a support to decision making.

After composing the layers of variables, the algebra of maps is structured in Weighted Average:

$$A_{ij} = \sum_{K=1}^{n} (P_k \times N_k)$$

Where:

Aij –The position in the array analysis (line/column), or of a pixel in map

n – Number of maps or layers of variables combined.

Pk – Percentage points or weight assigned to map or layer of variable k in the set of layers.

Nk – Values that means the significance of the degree of relevance of that component of legend for variable k for the final objective

The choice of weights must be very well documented and justified, must be open to revisions, and in most cases is where the system calibrations happen. The different modes of carrying out the choice of weights can be summarized in two groups of procedures: the evaluation guided by data and the assessment guided by specialist knowledge, what Bonham-Carter (1994) denominates "data-driven evaluation" or "knowledge-driven evaluation".

Among the processes of defining weights by "data driven" can be cited the methods that are based on data mining, which seek to identify trends of hierarchy of variables according to what happens in reality, measured by samples chosen in the investigated territory (Castro, 2010).

Among the processes of defining weights by "knowledge driven", consulting the experts, the objective is to receive feedback from those who understand the phenomenon and the reality investigated, and emits its opinions based on the probability and the state-of-the art of the variable. There are different methods to perform this consultation, but the most popular are the Thomas Saaty method and the Delphi method.

The Saaty's method (1980), called "Hierarchical Analysis of Weights", was developed in 1978 at the University of Pennsylvania. It defines the weights of each information plan according to its relative contribution to the ensemble. The goal is to decompose a complex situation in order to make the decisions about what is most important. The method proposes the comparison of variables pair-to-pair and is assigned a criterion of relative importance among them.

The Delphi method was originally proposed in the 1950s by American military industry, the Research and Development (RAND) with the goal to divide responsibilities and get the best solution that was a consensus among people involved. The name comes from the Oracle of Delphi, because the objective is to support the decisions. The argument is that judgments of groups are closer to reality and more accurate than simple individual trials.

According to Dalkey and Helmer (1963) the method is composed of questionnaires applied in rounds to specialists, and these rounds are interspersed with feedback, which aims the convergence of the opinions expressed by the participants. Some authors, as Linstone and Turoff (2002) argue that the number of rounds should be as many are necessary until it reaches the convergence of opinions. But against that we defend that consensus does not exist, and what can be obtained is the maximization of consensus, and because of that, based on a great number of expressive case studies, we made to choice of employing three rounds. In the process described in this paper, the weights were assigned by a small group of experts, who have very good knowledge about the thematic studied and about the city analyzed and, above all, knew about the reality and the conditions of life from young and illiterate adults who require the services of education.

B) VORONOI POLYGONS

The employment of Voronoi polygons as a model of analysis, allows, according to Xavier-da-Silva (2001), prognostic procedures in environmental analysis. The procedure prognosis allows:

> *" ... The proposition is to measure territorial influence of a phenomenon, based on conditions diagnosed and prescribed for a particular territorial extension. It is implicit in the term a foresight, which may be reflected in the overall equation of possible problematic environmental situations for which can be envisaged environmental control measures, through the application of procedures specific to certain geographical areas."*

The author (Xavier-da-Silva, 1999) thus explains the construction of the model:

> *"In computer terms, the model measures the distance of each point in the matrix Amxn until each generator point, being its relevance defined by the lowest of these distances. This relationship can be considered opposite, as the comparisons of all this distances computed shall define, by the shortest distance found, the relevance of polygons in construction. As a result, at the end of the checking of relevancy, all points in Aij matrix will be associated to a generator point from Voronoi Polygons. The plan is subdivided discretized in "k" irregular polygons, that integrates it."*

As part of the applications of SAGA-UFRJ, free software, the application of the Voronoi Polygons were very useful to determine areas of influence of the schools in the city of Divinópolis, what allowed to verify the degree of care to the population, especially in sectors characterized by high population density and high population in social conditions of illiterate. The result characterizes the reality and allows simulating, as a procedure of prognosis, where are the best locations for new future schools or to increase the vacancies in existing schools.

The principle of the Voronoi Polygon is more interesting than the Thiessen method, that is also based on gravitational analysis, because this last one is based on the principle that in the hole territory there are points which are closer to a source, and the result is a polygon whose distances between the source and the point are the lowest possible. The model of Voronoi Polygons is more than simple division of areas, as it also considers the influence of distribution in the territory and the distances from the source, but it´s a more robust model as considers also the mass of the source point and the environmental characteristics that deform the distributions. So, the model is a combination of territorial distribution of sources or generator points, environmental characteristics that work as friction, and the influence of the masses on generator points. This combination of conditions should have the power to organize the space and define the area of influence of each generator point, or to define for each position of the territory which generator point has influence over him, or polarizes it.

In the study of the areas of influence of schools, the model generates results defining which school polarizes each part of the territory in the city. But it is necessary to explain that when a school presents an area of great influence, this does not mean, necessarily, that it has a service so well placed that has great range (resulted from the "mass" applied), but it can mean that there are no other schools in the territory which could cause the subdivision of the area of influence.

With this definition of the methodology, the data collection was performed directly in the field and by bibliographic research. Maps and data where prepared to give support to the development of strategies to improve the EJA Experimental Design and to guide the creation of EJA new poles. This strategy, in this particular educational project, is necessary due to its fundamental principles of flexibility, regarding the profile of the student and specificity of their learning. These educational places must be close to the students' houses, located in positions ease to reach and must be reached by a greater demand of people.

1.2 THE DESIGN OF YOUTH AND ADULT EDUCATION – EJA

Focused to give opportunities to young people and adults who could not complete their studies in their own age, Youth and Adults (EJA) is understood today as a human right, and their own way of education within the Brazilian basic education (according to LDBEN 9394/96), which is characterized by critical dialogue between popular education and school education, and this dialogue, according Paulo Freire's theory, is fundamental to build the basis of EJA, especially the ideas of education considering popular knowledge and social experience of students. (Freire 1999).

Understanding the EJA, from the experiences of popular education, is to organize it so that the study program and courses are the expression of interests, ways of life, the experiences with the students considering formal and non-formal education. Within the system school, EJA must be flexible to the trajectories of these young people and adults, marked by continuing difficulties and exclusions in society.

The EJA is press – well, the collective and democratic construction, requiring participation of teachers and students in defining their times, their rules coexistence in the construction of knowledge, implying the disruption of individualistic and fragmented teaching experience. The EJA has an established curriculum in experiences of its subjects, and therefore requires time for collective planning and continuing teachers' education. The EJA is also understood as continuing education, because youth, adults and seniors should have a solid education in schools and in other areas such as technology centers, leisure and culture. Conceive it as continuing education is affirming the need for public policy of the state towards this type of education, with more resources and expansion of the right subjective to learning for all ages in our county. These were the guidelines indicated in the VI Conference International Adult Education.

According INAF - Indicator of Functional Literacy Institute, Paulo Montenegro Institute and the NGO Action Educational, in 2011 there are still 9 % of the population Brazil (11 million people) uneducated and awesome index 18% (over 23 million people) with incomplete primary education. The table below shows the numbers of population scholarity (table 1):

ILLITERATE	2000 CENSUS		PNAD 2009	
No schooling	10%	10.866.552	9%	11.766.782
Elementary school	30%	32.599.656	18%	23.533.564
Secondary School	28%	30.426.345	24%	31.378.086
High School	24%	26.079.725	35%	45.759.708
Top	8%	8.693.242	14%	18.303.883
total	100%	108.665.519	100%	130.742.024

Tab. 1 Scholarity of the population from 15 to 64 years old in Brazil/IBGE - Source: INAF 2011

In smaller geographic divisions, in the city of Divinópolis / MG, illiteracy and low education data confirm the general dates of education of Brazilian's population. According to the 2010 census realized by IBGE, the population of Divinópolis is 213016 people, and of these, 356 attended young and adults' literacy, 317 at public schools and 39 on private ones. According to the census in Divinópolis there are 84023 people with more than 10 years old who are illiterate, and 60,764 people that are adults above 25 years who has just incompleted elementary education (table 2).

meso, microregions and municipalities	Total	LEVEL OF EDUCATION				
		illiterate and fundamental incomplete	fundamental complete and average incomplete	average complete and upper incomplete	upper complete	not determined

Divinópolis	133600	60764	21837	33580	17222	257

Tab. 2 People that are more than 25 years old Source: IBGE - 2010

The experimental design was established starting from the municipal legislation called "Municipal Organic Law of Divinópolis" which states that primary education should be free and compulsory, even for those who did not have access at the right age. The "Decennial Education Plan of Divinópolis", 2004/2013 (FUNEDI, 2013), presents the chapter "Concerning the Youth and Adults Education", establishing as a goal to eradicate illiteracy and universalize elementary education for youth and adults over fifteen years. The Experimental Design EJA, in seven years of existence, has been serving on average of 400 students per year, in eight public schools, with 32 educators.

2 APPLICATION OF VORONOI'S POLYGONS, MULTICRITERIAL ANALYSIS AND KERNEL'S DENSITY FOR DIAGNOSIS OF TERRITORIAL INFLUENCES IN EJA'S POLES TO DEFINE FUTURE STRATEGIES OF DEPLOYMENTS

Were selected seven municipal schools which receives the EJA project in Divinópolis: CETEPE, E.M. Emílio Ribas, E.M. Professor Darcy Ribeiro, E.M. Professora Veneza Guimarães de Oliveira, E.M. Professora Hermínia Corgozinho, E.M. João Severino de Azevedo e E.M. São Geraldo. The aim of the study was to demarcate the area of influence of such schools, in order to analyze if the location matches the needs of the students from EJA.

The Voronoi's Polygon was applied in the simple and in two complex models. The simple model aimed the understanding of geometric distribution of the areas of influence. The first complex model considered just the mass values on school points, composed by the average between the number of students and the number of teachers, and results in simulation of territorial influence of each point considering spatial arrangement of all points e their mass values. Finally, second complex model of Voronoi's Polygon considers spatial arrangement of all points e their mass values, but also the friction (impedance to spread the influence) along the territory, thus observing spatial variables that interferes in access conditions to the schools with EJA.

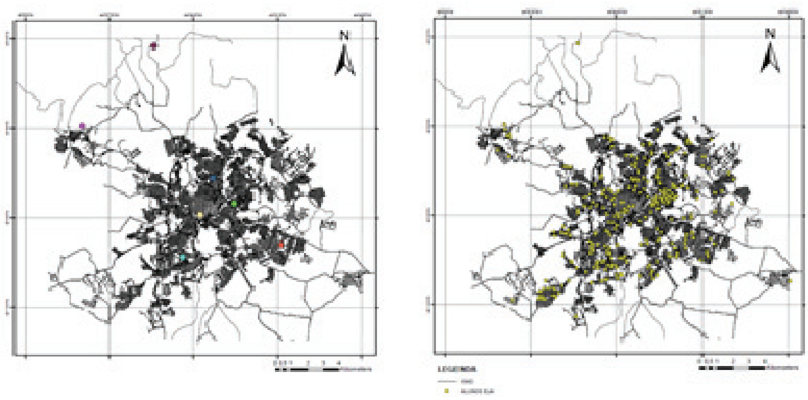
2.1 - METHODOLOGY

Maps and data were collected and organized from various institutions. Initially it was necessary to obtain roads and streets maps from Divinópolis City Hall and provide topological corrections and georeferencing, as they came in cad format.

Alphanumeric tables were organized, presenting data from each school about number of teachers and students, as well as the addresses of students and the location of the school. These data were tabulated, and through the plugin MAPCITE the addresses were converted into geographic coordinates in WGS84 reference, and subsequently converted into SAD69 (Brazilian datum) and resulted in location points of EJA schools and of all the students. (Figure 1).

Because of lack of data, a school which was out of Divinópolis city, in a district in the municipality, was excluded from the analysis. It was not also possible to georreference the addresses of students who live in rural areas, and to deal with this problems they were located in the schools they study, as in this small locations or districts there's just one single school.

To analyze the current situation of concentration of students of EJA'S it was applied the kernel's density, developed from school points and weighted by the number of students in each school. (Figure 1, Figure 2, Figure 3).



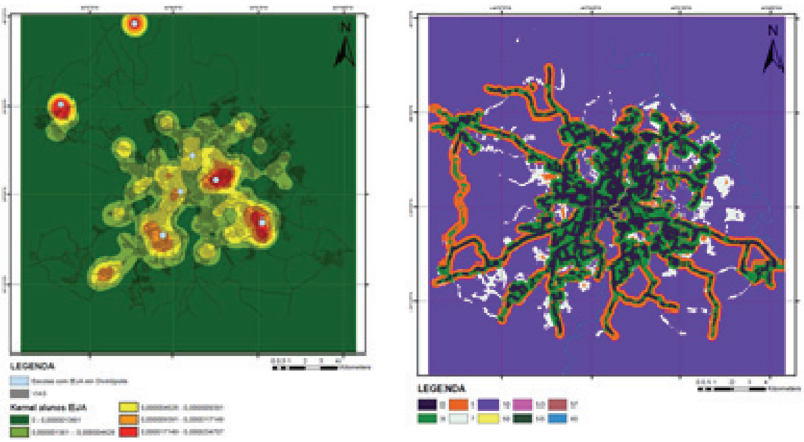
Figg. 1, 2 (1) Distribution of schools. (2) Distribution of students

A map of friction was produced, in order to provide a distribution of difficulties to mobility over the territory. Through literature review and interview with experts, it was decided to take as variable to build this synthesis map the combining of slope; capillary of pathways, the presence of the bus line and the presence of large watercourse which produces barriers in Divinópolis. These variables were combined in Multicriterial Analysis using weighted average according to the importance given by the experts who knows the city and its reality, and this synthesis results in friction map.

The most important map in this synthesis was the route of bus lines, because they are considered the main transport way used by students. It was defined a buffer of 100 meters from the routes, considered the ideal condition, and another buffer of 300 meters, considering an acceptable condition. The second most important map was the capillary of streets and roads, built with kernel's interpolator. It was produced the map of slopes and the map of rivers. Map of friction was generated by grouping all the maps through a Multicriterial Analysis. (Figure 4).

The multicriterial analysis procedure is widely used in advanced geoprocessing because it is based on basic logic building a GIS: selection of key variables that characterize a phenomenon, conducted by a methodological approach for simplifying spatial complexity; representation of reality according to different variables, organized in layers of information; discretization of levels of analysis in space resolutions appropriate for both sources of data but also to the objectives to be achieved; promoting combination of layers of variables, integrated as a system that reflects the complexity of reality; finally, calibration and validation of the system.

It was decided to assign greater value to the presence or absence of buses (50%), capillarity (30%) and the slope (20%). After this first combining, the presence of rivers were considered reducing the condition of mobility, mapping the bridges as areas with conditions and the river line as obstacles.



Figg. 3, 4 (3) Kernel Density of students. (4) Map of friction

Once produced the friction map and other maps, the entire database was transferred to the software SAGA - System for Geo-Environmental Analysis, developed by Prof. Jorge Xavier, the Lageop - UFRJ, where the model Voronoi polygon was applied. The principle of Voronoi's Polygons' is that, considering a territory, there are points that are closer to a generating source than another source, and the result is a polygon whose distances between source and point are as small as possible. The resulting polygons can go beyond simple division of areas and be deformed by environmental characteristics, which are considered friction, and by the influence of mass values applied to the generating points, and the model have the power to organize the space and define the area of influence of the point.

The model developed by Prof. Jorge Xavier and available to use in SAGA software is a more robust model than the Voronoi application presented in others software. It's not only a Thiessen Polygons', but it's a spatial analysis based on gravitational model that combines the spatial distribution conformed by the points of irradiation, the mass points considering factors which give importance or values to origins of the irradiation, and the friction on territory which works as benefits or costs (difficulties or facilities to spread the influence over the space). It applies the mathematical logic:

$$(FZ)Gi = MGi / [(Dx \rightarrow Gi)Ax \rightarrow Gi]$$

Where:

(FZ)Gi = Force of zoning of point Gi;

MGi = Mass value of point Gi ;

Dx → Gi = Euclidean distance between each point analyzed and point Gi; e

Ax → Gi = Σ Ck (from 1 to n)

Where:

n = number of cells (pixels) found in the way between x and Gi;

Ck = value of friction estimated to each cell (pixel) in the way between x and Gi.

In this study, the complex Voronoi proposed by Xavier was used, with mass determined by the composition of the number of students in schools and number of teachers, determining a factor used as mass value, and also taking into account the environmental friction.

Besides the calculation of Voronoi it was provided a map of kernel density considering the interests of population, as in 2012 the Municipal Education Secretary of Divinópolis made a public consult to register the interests on the program, what resulted in a table presenting the number of interested people by neighborhood. This polygons of neighborhoods where converted in centroids which received as mass values with the number of people who were interested, and a kernel density was applied, to promote the visualization of spatial distribution of concentration of interests in taking part of the program.

To conclude the study, analyzes were performed to identify new areas to promote new places for the project, to verify the adequacy of spatial distribution of schools and to identify areas where the possible students were not well reaching educational services.

2.2 ANALYSIS OF RESULTS

After the model of complex Voronoi was built considering the number of vacancies or possible enrolments in school as mass value and the territorial friction to reach the school point; after constructing the map of students distribution; and after promoting the spatial density analysis of the concentration of possible students registered by the inquiry done by the municipality, they were compared. The goal was to verify the degree of promoting these educational services to the population. The result can provide support in decisions making of new locations of future schools or in the allocation of new vacancies in existing ones.

Analyzing the results, the large influence of a single school does not necessarily mean that it presents a satisfactory broad coverage, but it may means that there is no competition with other school in the same territory in the subdivision of the areas of influence. The large surfaces must be considered negative.

The small territories presented by the areas of influence must also be considered negative, because they mean the spatial concentration of opportunities.

The model allows simulating possible changes. These changes can be, for example, the increasing of mass (number of possible students to be received combined with the increasing of number of teachers) and check the effect of the decision done.

The analysis of friction map allows verifying that worse areas, with grater friction, are in the western part of the city. The best areas, with greater conditions of ways to go from one place to another are the central ones, but in places where the river acts as a barrier it's reduced. (Map 6).

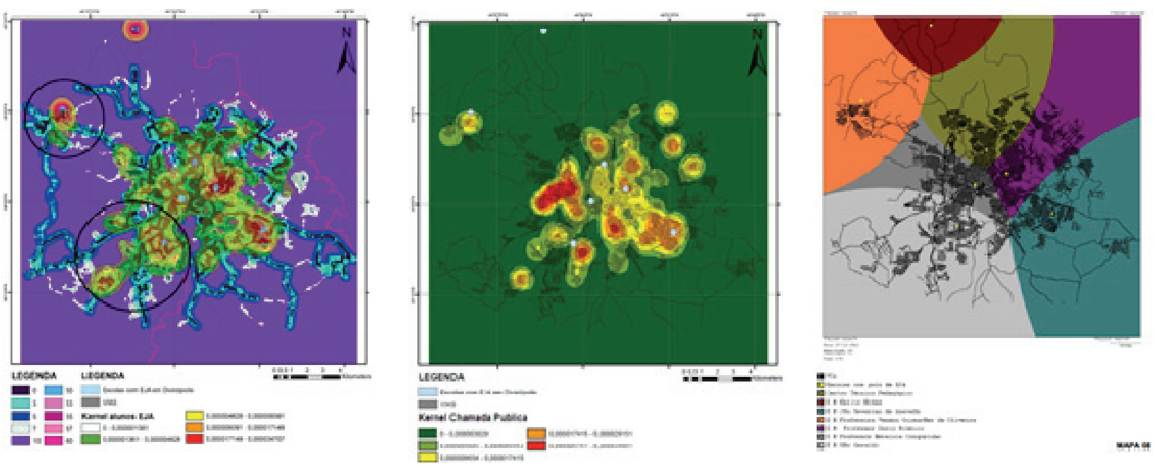


Fig. 5, 6, 7 (5) Combining of students' distribution with friction map. (6) the map of kernel density considering the manifestations of interests registered by the municipality consult. (7) Voronoi with mass factor.

It was promoted the combining of students' distribution with friction map. (Figure 5) The regions marked by the circle shows that the majority of students are in areas of high friction, where the presence of bus ways occurs generally only along avenues, resulting in isolation of these students in their areas of residence.

The map of Kernel density considering the manifestations of interests registered by the municipality consult in 2012 demonstrates that the demand of students who wanted to enroll in adult education are more concentrated in a different territory from the those where there are already students served by the program. (Figure 6).

The first complex Voronoi models, which takes into account only the mass on points of irradiation, demonstrates that schools with similar mass factor (number of students + number of teachers), but distributed differently the along the territory, have their areas of influence enlarged or reduced, according to the competition with other opportunities. (Figure 7).

At St. Gerard School, for example, there is a large area of influence due to its high mass value (table 3):

NAME	NUMBER OF STUDENTS	NUMBER OF TEACHERS	FACTOR
Centro Técnico Pedagógico	79	3	41
E.M.Emílio Ribas	22	2	12
E. M. Professor Darcy Ribeiro	93	4	49
E.M. Profª Hermínia Corgozinho	92	4	48
E. M. Profª Veneza Guimarães de Oliveira	46	5	26
E.M. São Geraldo (Centro)	113	5	59
EM. Benjamin Constant	16	5	11
E.M. João Severino de Azevedo	75	4	40

Tab. 3 Mass factor

The second complex Voronoi was performed taking into account the factor of mass and the friction of the territory (map 04). The areas of influence decrease/increase according to the degree of difficulty to access the school point, and according to the level of attraction represented by mass values. It was made an overlap between the complex Voronoi (mass + friction) with the map of Kernel density of people interested in taking part of the EJA program, to analyze which schools could be better to receive the students.

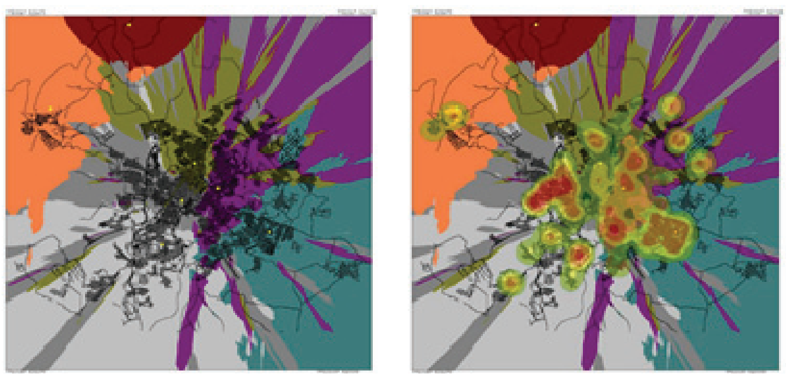


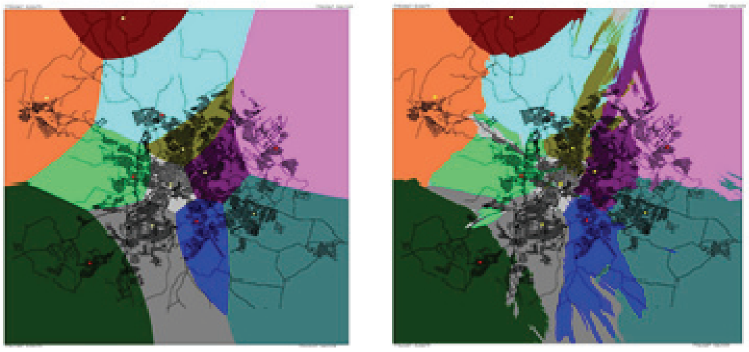
Fig. 8, 9 (8) Voronoi with mass factor and friction. (9) Voronoi with distribution of interest students

3 CONCLUSIONS

The aim of this paper was to use the Multicriterial Analysis and the Voronoi Polygons in urban studies, to support decision making in the distribution of opportunities of centers called Educação de Jovens e Adultos – EJA (centers of education for youth and mature people) in Divinópolis – MG. After several analyzes, it was conclude that Divinópolis needs a higher number of EJAs. The demand is greater than the number of vacancies at EJA´s. It's also important to observe that there is a deficit in education in Divinópolis, higher than the national average. It's necessary to increase opportunities in number of vacancies and in number of centers, because the program must meet not only people wishing to attend the project, but it is also ensures that this centers can work according to flexibility and suitability, what means to be integrated in society and in the territory activities. (Figure 10 and Figure 11).

It was observed a spatial location which needs to be more served: São Geraldo and Professora Hermínia Gorgozinho. The first school presents a high demand for new opportunities and has low values of territorial friction. The second school has also a high demand for new opportunities or vacancies and low territorial friction, as it´s placed in a location with good access to public transportation, with high capillarity.

Studying the places to put new schools or to rise the number of students to be received, it is possible to conclude that is necessary to create five new centers, distributed on the follow schools: EM Padre João Bruno/CAIC, EM Joaquim Rodrigues, EM Otávio Olímpio de Oliveira, E.M. Sidney José de Oliveira and E.M. Professor Bahia. These schools were chosen by their proximity to the higher demand of students and to share more areas of influence. To investigate the suggested places, a new Voronoi simulation was performed taking into account the new values projected as sceneries. (Figure 10 and Figure 11).



Figg. 10, 11 (10) Voronoi simulating changes in mass values. (11) Voronoi simulating changes in mass values and considering friction

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Figg. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11: The authors

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RURAL ARCHITECTURAL INTENSIFICATION

A MULTIDISCIPLINAR PLANNING TOOL

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ABSTRACT

When approaching a composite territorial problem that involves different scales and disciplines, it is necessary to establish a precise logical framework. Every planning or design activity is an iterative process applied to a complex system; not linear relations among the entities that compose the system are numerous and it is problematic to spell out them.

Authors developed a framework that has a hybrid structure in which different classical tool such as Spatial Decision Support Systems, Knowledge Discovery and Data Mining (KDD), and Expert Systems (ES) converge.

The method is not completely automatic and there is a continuous interaction between user and system.

The main aim of the entire research group who participated to a national research (PRIN 2009) was to define an informed methodology for decision makers, stakeholders and public bureaus who have to (or want to) face the problem of improving and intensifying insediative activities in minor centers located in rural-urban context.

In particular authors defined Rural Architectural Intensification (RAI) as a way to improve territorial features throughout a serie of interventions in small settlements and buildings.

The explanation of the relations among different disciplines, different scales and different related methodologies is the key point of the paper.

After an introduction and the description of RAI, authors introduce the main methodological structure; then each passage is detailed and specified considering the elements involved and the technical operations.

KEYWORDS

Rural Architectural Intensification; Multidisciplinar approach; planning tool; methodology explanation.

1 INTRODUCTION

The paper describes methodology and results of a branch of a PRIN 2009 research (relevant research at Italian national level) aimed to define theoretical and practical solutions for rurban context. Authors expose a Spatial Decision Support System with a specific application to Rural Architectural Intensification (RAI).

The whole process involves different scales (at least: territorial and architectural) and different disciplinary fields such as: regional planning, landscape and environmental planning, architecture, social sciences, economy (Blaschke 2006).

Within this methodological process many basic concepts of Smart Growth are taken into account. They are: Land Preservation; Preventing urban sprawl; Development Best Practices; Preservation Development; Mix land uses; Take advantage of compact building design; Create a range of housing opportunities and choices; Preserve open space, farmland, natural beauty, and critical environmental areas; Make development decisions predictable, fair, and cost effective; Encourage community and stakeholder collaboration in development decisions.

The entire research bases on a general procedure (quite similar to classical planning ones) in which the main aim is RAI. Applications depend on possible specific aims that put into effect this principal objective.

For each of these two main phases themes, techniques and tools are defined.

2 RURAL ARCHITECTURAL INTENSIFICATION

Rural Architectural Intensification (http://www.raintensification.com/#!home-english/ceab) has been defined by the local research unit of the University of Pavia (coordinated by Prof. Tiziano Cattaneo) inside a general framework (coordinated by University of Ancona) "Architecture as Heritage: innovative instruments for the tutelage and the improvement of the local border systems". Authors from University of Pavia participated with the research theme: "Regeneration and renewal of rural landscape. Building strategies in the surroundings of new urban centers" (Frampton 1991; Carboz 1998; Thompson, Sorving 2000; Jongam 2002).

Rural Architectural Intensification is an innovative design action for architecture and urban design. This operative action is applicable for regenerate and transforms the contemporary city-landscape into uses that are suitable for contemporary ways of living through the construction of a new paradigm that will shape an architectural and urban project committed to sustainability. Rural Architectural Intensification has three keywords: Rural as environment with richness of history, values, memory and high quality; Architecture as a process and construction product, which can create social, cultural, economic and technological innovation; Intensification as a strategy to create sustainable density of activities and spaces for people in which the natural environment and the rural-urban environment coexist harmoniously.

This issue aims to the regeneration of the rural landscape as cultural heritage (Van der Vaart, 2005; Spaziante, Murano 2009; Fuentes 2013). The crisis in rural areas is essentially a European problem: depopulation and ageing of the population, abandonment and decay of small town centers, difficulty in keeping existing businesses and/or in launching new start-ups, intensive agricultural practices to the detriment of biodiversity, pollution, a lack of infrastructures and services for tourism, as well as a shortage of job opportunities for the population, etc.

Enhancing rural architecture, small towns, farmsteads and ancient relics is one of the main components for the regeneration of the countryside. It is a strategy with a positive outcome, even only if it has been supported simultaneously by the possibility of creating more business (also working from this architectural heritage), but which nevertheless is planned taking into account the improvement of the perceived aesthetic structure of the countryside.

The main methodological approach here presented, previously defined as a Decision Support System, is a hybrid solution among Spatial Decision Support System (SDSS), Knowledge Discovery and Data Mining (KDD) e Expert System (ES) (Densham 1991; Wang, Feng 1992; Fayyad, Piatetsky-Shapiro, Smyth 1996; Keenan 2003).

3 MAIN PROCEDURE AND TERRITORIAL APPLICATION

The following flow diagram (Fig. 1) represents the entire planning method. Authors consider it is essential to specify the sequence of the phases that characterize the whole process because it combines various approaches that can be referred to the different scales and disciplines involved.

The aims are defined by decision makers, stakeholders, public bureaus, developers or private associations and the procedure is addressed to planners and to professional figures that may ease the decision process.

The process starts with the identification of a “main aim”, that is the final goal of the whole planning procedure; in this case it is RAI.

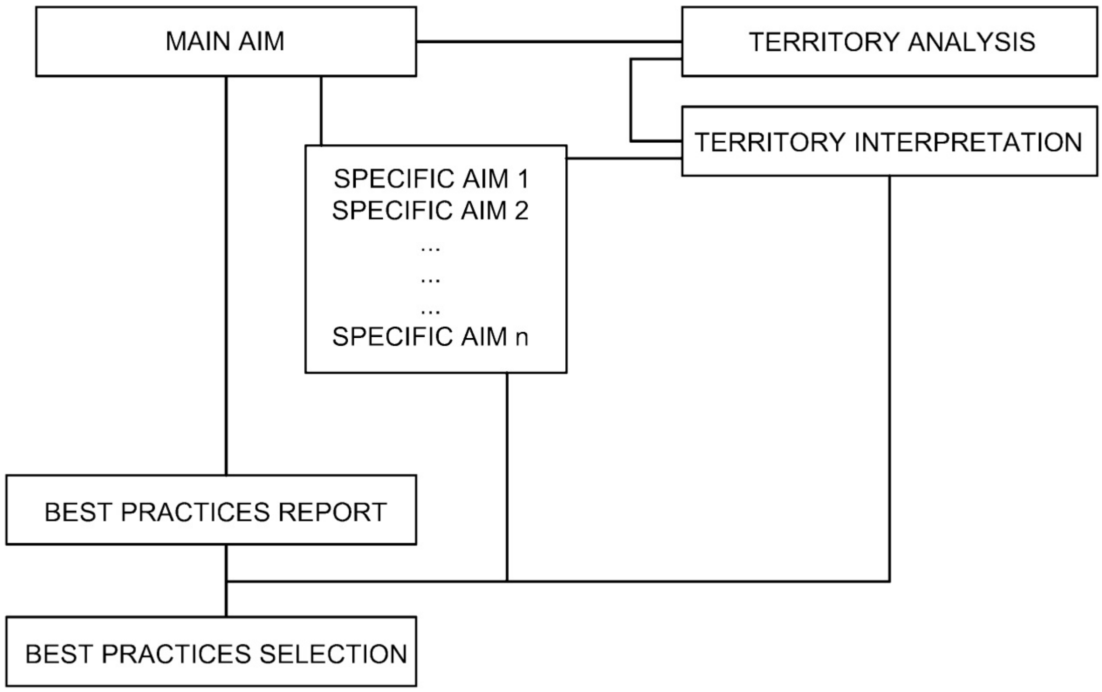


Fig. 1 Logical framework

Considering that RAI application depends on the characteristics of the territory in which it should work, once the main aim is defined, planners analyze the territory starting from available net information (such as Regional and local webgis, DUSAF, CORINE, etc.).

A Best Practices Report was built during the RAI research and it is a basic thematic reference in which many experiences from all over the world are classified and assessed depending on specific criteria.

Considering the characteristics of the analyzed territory, decision makers and stakeholders define specific aims; these are in example: concentration of new commercial activities in existing small centers, creation of a system of mixed use small centers, creation of a decentralized hotel, definition of territorial facilities, distribution of residential settlements in existing underused buildings, renewal of existing rural settlements, etc.

Obviously, territorial interpretation depends on certain specific aims: in fact different spatial or economic factors may have particular relevance for each precise objective. At the same time the entire Best Practice database can be consulted and appropriate examples may be selected.

Lastly a compatibility assessment among the territorial interpretation and the selected case studies carries to possible scenarios that decision makers and stakeholders should consider.

In the following schemes, two phases are singularly analyzed.

The first phase consists on the Territorial Analysis and on the creation of the Best Practices Report (Fig. 2a and 2b).

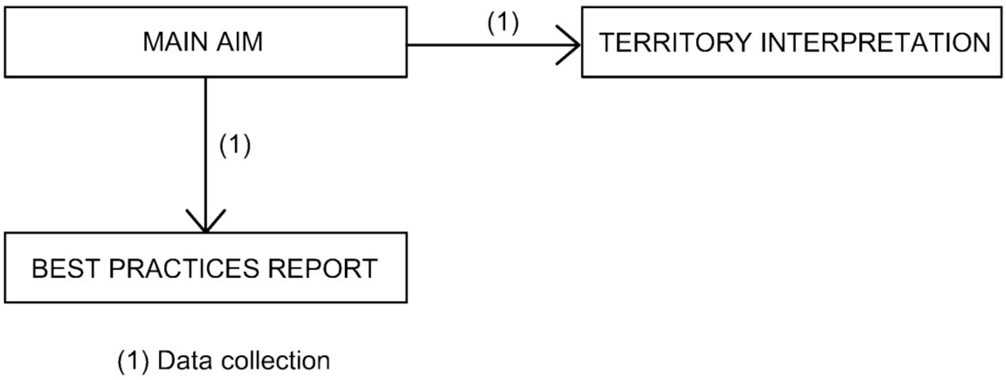


Fig. 2 a First Phase

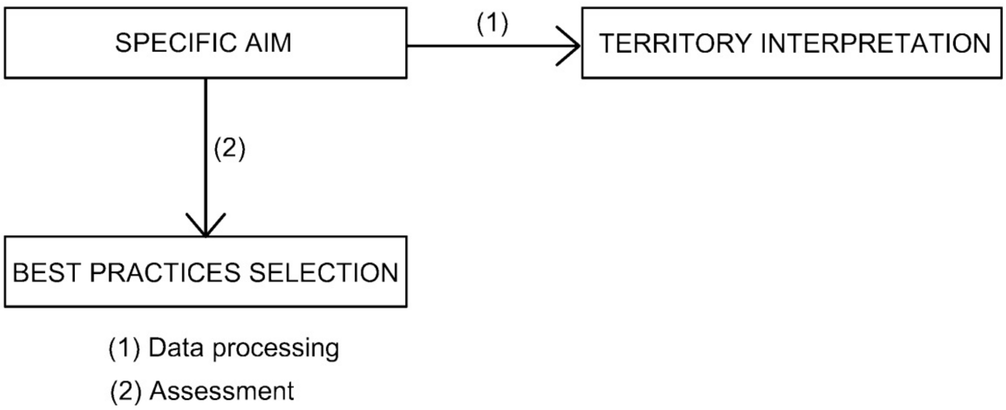


Fig. 2 b First phase

In this phase two actions are developed simultaneously: one is driven mainly by planners (Territorial Analysis) and the other mainly by architects (Best Practices Report). Different scales and disciplines are involved and they may work separately.

Territorial Analysis starts with the creation of a wide GIS-based database about all available information that may be useful for a comprehensive description of the territory under investigation (*Cano, Garzón, Sánchez-Soto 2013*). Together with all environmental and landscape information, in this database a particular attention must be paid to existing and underused architectural assets. In fact they represent the starting point for RAI strategies.

In RAI application a specific best practices database already exists: http://www.raintensification.com /#!case-report/c1zi1. It reports carried out and successful projects related to urban, rural and fringe contexts from all over the world.

In the Best Practice Report built for the main aim RAI, each project is catalogued by four parameters:

a. development of local business capability;
b. development of cultural and tourist activities;
c. environment preserving;
d. facilities for population.

With more details:

a. development of local business capability: business and tourism, diversification into non-agricultural activities, diversification and innovation in agriculture, cultivate the landscape, cooperation and short chain, growth of the bio-economy, business and infrastructure;
b. development of cultural and tourist activities: tourism and architectural heritage, tourism and environment, small-scale tourism services, countryside vs sea and mountain, tourism and water, tourism and infrastructure, tourism in less-favorable areas;
c. environment preserving: environment and biodiversity protection , environment as heritage, environment and water, soil and environment, environment and animals, environmentally sustainable operations, limit consumption of the environment, bioenergy, environmental reservoirs, environment and urban space, environment and infrastructure, environment and waste, environmental risk, environment in disadvantaged areas, diversified environmental redevelopment;
d. facilities for population: population and employment: tourism, population and employment: diversification of agricultural activities, essential services to the population, country-city, population: energy saving, young population, population: infrastructure, cooperation in development, safe population, population and environment.

The characteristics of the specific aim (that decision makers or stakeholders select) guide the data processing that aims to acquire knowledge from the information layers.

At the same time, basing on the thematisms of each example that compose the Best Practices Report, decision makers or professionals circumscribe a coherent selection with the specific aims.

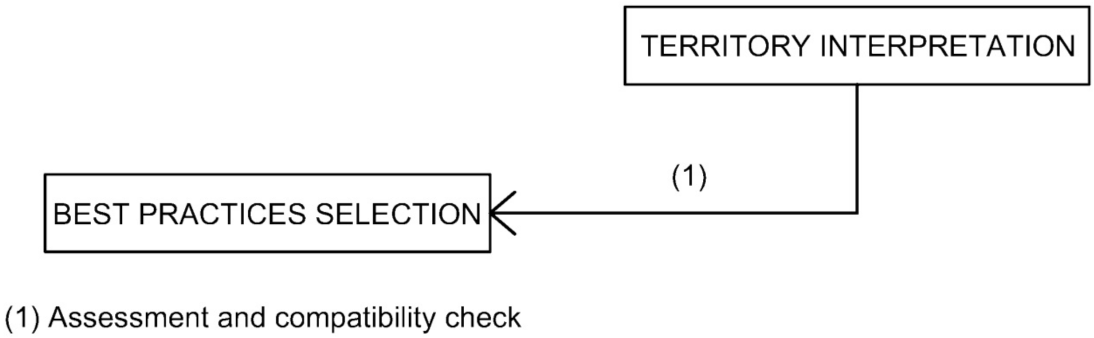


Fig. 3 Second phase

In the second phase (Fig. 3) the output of the Territorial Interpretation defines the boundaries wherein selected case studies have to stay. This assessment among the multiple possible solutions is a compatibility check between the opportunities and limits of the territorial context and the specific goals that each example is able to reach (goals that depend on the specific aim).

In the following scheme (Fig. 4) logical connectors link all the issues and elements involved in the two phases.

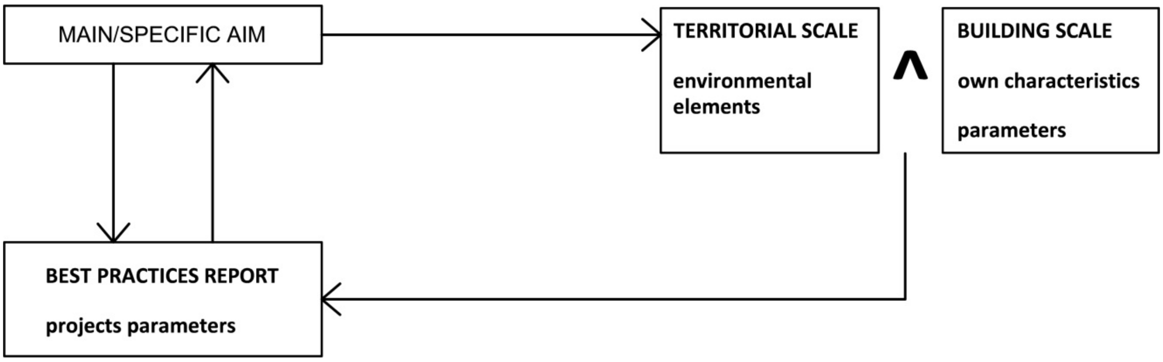


Fig. 4 Involved issues and elements

where:

- Environmental elements are: rows, plantings, hydro-net, land use, REN-regional ecological network, urbanized areas, infrastructures, restrictions;
- Own characteristic are: areas, year of building, state of preservation, state of use, function, restrictions;
- Parameters and projects parameters (a, b, c, d).

With reference to Fig. 4, Fig. 5 illustrates the techniques exploited in each passage.

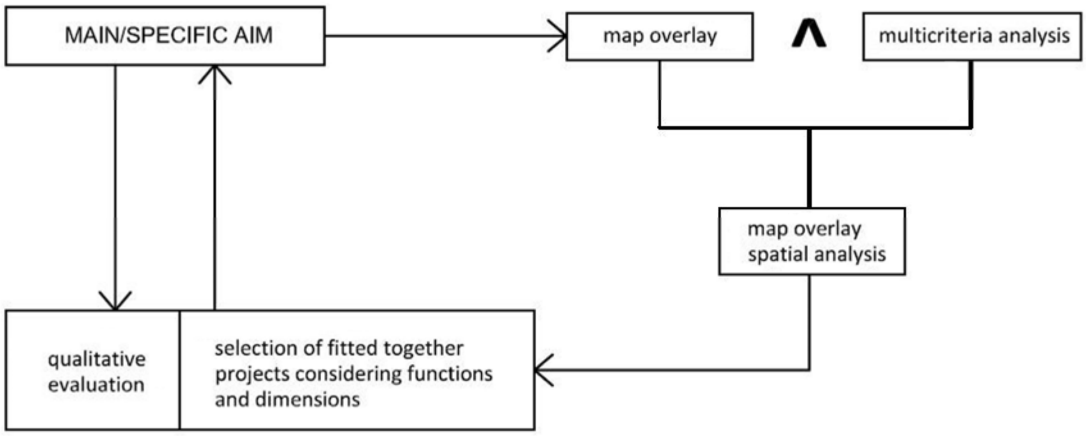


Fig. 5 Exploited techniques

Inside Territorial Scale box the technical operation is basically a map overlay; in Building Scale box the operations are based on a multicriteria analysis that uses the previous four criteria (*Voogd 1983*). In turn the crossroad of the two sets is assessed by map overlay and spatial analysis (*Murgante, Borruso, Lapucci 2009; Murgante, Danese 2011*): in this way the territorial interpretation guided by the specific aim is complete.

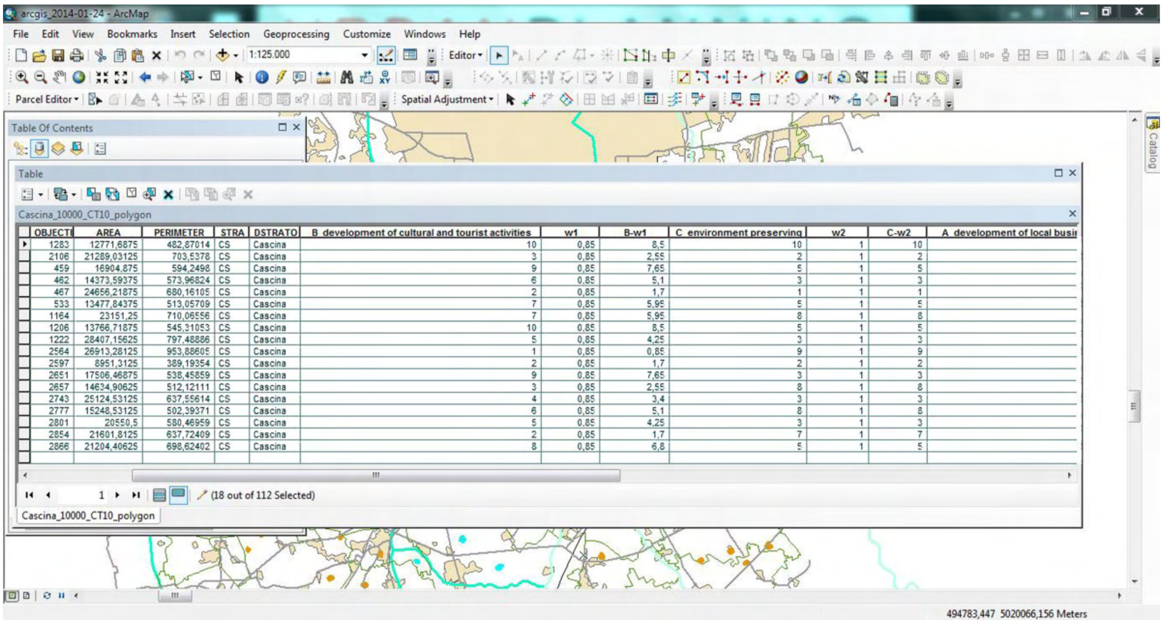
The qualitative evaluation is described in the next chapter. Once the territory is appropriately read, it is possible to choose the selected case study that fit with the territorial characteristics. In Tab. 1 there is a synthesis of the main considered elements and used techniques.

	TERRITORIAL SCALE	BUILDING SCALE
Data source and tools	Gis and cartography	Gis and cartography, hyperlink, bibliography, automatic survey
Data processing	Map overlay	Multicriteria evaluation
Elements	Water, soil and urban settlements	*Cascine*: rural settlements

Tab.1 Synthesis of considered main elements and techniques

Fig. 6 reports an example (from ESRI ArcGIS) of an attribute table that contains all the information connected to a single rural settlement (specifically a so called “cascina”).

In addition to the physical parameters obtained by simple spatial interrogations, there is an evaluation of the previous four parameters (a, b, c, d) and the weights (a-Wn, b-Wn, c-Wn, d-Wn) assigned by planners or decision makers considering the specific aim.



Cascina_10000_CT10_polygon

OBJECTI	AREA	PERIMETER	STRA	DSTRATO	B development of cultural and tourist activities	w1	B-w1	C environment preserving	w2	C-w2	A development of local busi
1283	12771,6875	482,87014	CS	Cascina	10	0,85	8,5	10	1	10	
2106	21289,03125	703,5378	CS	Cascina	3	0,85	2,55	2	1	2	
459	16904,875	594,2498	CS	Cascina	9	0,85	7,65	5	1	5	
462	14373,59375	573,96824	CS	Cascina	6	0,85	5,1	3	1	3	
467	24656,21875	680,16105	CS	Cascina	2	0,85	1,7	1	1	1	
533	13477,84375	513,05709	CS	Cascina	7	0,85	5,95	5	1	5	
1164	23151,25	710,06556	CS	Cascina	7	0,85	5,95	8	1	8	
1206	13766,71875	545,31053	CS	Cascina	10	0,85	8,5	5	1	5	
1222	28407,15625	797,48886	CS	Cascina	5	0,85	4,25	3	1	3	
2564	26913,28125	953,88605	CS	Cascina	1	0,85	0,85	9	1	9	
2597	8951,3125	389,19354	CS	Cascina	2	0,85	1,7	2	1	2	
2651	17506,46875	538,45859	CS	Cascina	9	0,85	7,65	3	1	3	
2657	14634,90625	512,12111	CS	Cascina	3	0,85	2,55	8	1	8	
2743	25124,53125	637,55614	CS	Cascina	4	0,85	3,4	3	1	3	
2777	15248,53125	502,39371	CS	Cascina	6	0,85	5,1	8	1	8	
2801	20550,5	580,46959	CS	Cascina	5	0,85	4,25	3	1	3	
2854	21601,8125	637,72409	CS	Cascina	2	0,85	1,7	7	1	7	
2866	21204,40625	698,62402	CS	Cascina	8	0,85	6,8	5	1	5	

(18 out of 112 Selected)

Fig. 6 A single rural settlement attributes table (software: ESRI ArcGIS)

4 QUANTITATIVE AND QUALITATIVE ASSESSMENT

It is necessary to specify in which way each project of the Best Practices Report can be assessed in a qualitative and in a quantitative way.

Following what previously mentioned, there are four main criteria that guided the cataloguing procedure. For each specific aim, criteria assume different relevance (or, in other words, each project may have marked performances for certain criteria).

In Fig. 7 there is an example of a qualitative assessment of a certain project. Each criteria is divided in sub-criteria that the project may satisfy or not.

Fig. 7 Example of qualitative assessment

In a quantitative assessment the cited relevance can be synthesized with a weight. The weights are assigned by decision makers, or experts such as planners and architects or also common people if the specific aim demands social involvement. A pairwise comparison is a diffuse methodology that is applied also in this case (Fig. 8).

Specific Aim				
	Local business	Culture + Tourism	Environment	Population
Local business				
Culture + Tourism				
Environment				
Population				

Evaluation	
Local business	x
Culture + Tourism	y
Environment	z
Population	t

Fig. 8 Example of quantitative assessment

In the compatibility check phase (the final phase of the entire procedure) decision maker compares real information about the minimum built units such as small rural settlements or "cascine" (described using the same parameters a,b,c,d) with the result derived from the qualitative or quantitative assessment of the case report.

Decision maker will select the projects that have performances similar to the studied minimum units.

Qualitative assessment could be transformed into a quantitative one throughout:

- A weighted sum of elements considering how many sub-criteria are satisfied. In Fig. 7 example "Local business" is 1 on 7, "Cultural + Tourism" is 1 on 7, "Environment" is 3 on 15 and "Population" is 1 on 7. These values may become fractions. Once a weight is associated to each parameter decision maker obtains a numerical value (Wa x 1/7 + Wb x 1/7 + Wc x 3/15 + Wd x 1/7). The value itself is not meaningful but it is useful to build a ranking among the selected case studies;
- The well known "Fuzzy logic" (*Terai, Asano, Sugeno 1992; Borri, Concilio, Conte 1998*) can be used to transform such qualitative evaluations (in fact, even if it is possible to define how many sub-criteria a project satisfies, this decision is always highly subjective). With Fuzzy Logic it is also possible to synthesized more complex evaluations derived from non expert judgments. Moreover Fuzzy is also useful in the final phase of compatibility check because the compatibility has often wide ranges of doubts and shades.

4 CONCLUSIONS

The research aimed to focus on methodological aspects that regard (and come from) different disciplines. Multidisciplinary is a keyword in recent times but it is not easy to define procedures that can put together quantitative and qualitative, and subjective and objective evaluations into a unique decision process.

The methodology is sufficiently general to be applied to very different contexts and some real applications are needed to test it.

Authors implemented quite all the passages in an automatic tool but some passages need a deeper review.

In example, a semantic indexation of the case study could furnish a more clear (and fast, once well tested) evaluation of the multitude of projects that may respond with more or less coherence to specific needs.

The complete computerization of the process is the main aim that authors would like to reach but the resulting system will always be a DSS in which decision maker interact in all the steps and can control each weight basing on specific aim or personal considerations.
The last passage that still must be faced is the GUI. The interface depends on the typology of users that the system is addressed to and at the moment no specific profile has been defined. Surely authors will start with expert users.

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LANDSCAPE PLANNING AND ECOLOGICAL NETWORKS

PART A

A RURAL SYSTEM IN NUORO, SARDINIA

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ABSTRACT

Urban-rural landscape planning research is nowadays focusing on strategies and tools that support practitioners in designing integrated spaces starting from the analysis of local areas, where human and natural pressures interfere. A prominent framework is provided by the ecological networks, whose design regards the combination of a set of green areas or patches (the nodes) interconnected through environmental corridors (the edges). Ecological networks are useful for biodiversity protection and enhancement, as they are able to counteract fragmentation, and to create or strengthen relations and exchanges among otherwise isolated elements. Biodiversity evolution, indeed, depends on the quantity and quality of spatial cohesion of natural areas. In this paper, we aim at designing an ecological network for the periurban area on the town of Nuoro in central Sardinia. The narrative unfolds in two parts. Part A is presented in this paper and includes its methodological premises, i.e. biodiversity conservation and ecological network analysis and design, and the introductory elements of a spatial analysis on a pilot ecological network of one hundred patches. We locate patches by focusing on the ecosystems supported by the target vegetal species holm oak (*Quercus ilex*) and cultivated or wild olive (*Olea europaea* var. *sativa*, *O. europaea* var. *sylverstis*). These are very common plants species in the municipality and some animal species are active as seed dispersal. The reminder, i.e. Part B, of the essay is presented in an homonymous paper that focuses on the illustration of the network analysis conceived as a monitoring system and, in future perspective, as a planning support system.

KEYWORDS

Rural-urban landscape, ecological networks, target species, dispersal distance

1 INTRODUCTION

The development of human settlements has often caused severe interferences with local ecosystems that have resulted in loss of biodiversity. In this respect, uncontrolled pace of building activity and erosion of public spaces and green areas are major determinants. Nowadays planners are faced with urban landscapes often in need of policies directed to the conservation of biodiversity. A prominent strategy able to satisfactorily meet these needs is the construction and management of ecological networks, i.e. a system of punctual green areas interlaced through material (corridors) or immaterial connections. In a number of cases municipalities have successfully adopted that strategy to counteract biodiversity decrease through the reintroduction of certain vegetal and animal target species in peri-urban and urban landscapes. The analysis of the structure and behaviour of ecological networks is often based on graph theory, a discipline that has recently been renewed due to the developments of complex network analysis and to the availability of large data sets and computational power and tools.

The aim of this paper is to study the ecological network of the town of Nuoro, Sardinia and to build a network based analysis that may act as a monitoring tools and ultimately a planning support system. The argument is presented in two papers titled with the extensions "Part A" and "Part B". This paper unfolds as follows. In the second and third sections, we present our main concerns and methodologies regarding biodiversity conservation strategies and ecological network analysis, management, and planning. In the fourth section, we apply a complex network analysis to the characterization of an ecological network for Nuoro, Sardinia. For the remainder of the essay, we refer to paper Part B.

2 BIODIVERSITY AND ECOLOGICAL NETWORKS

For much of the 20th century biodiversity conservation, understood in its classical meaning as "the variety of life found in a place" (Encyclopædia Britannica, 2014), has found in the establishment of natural protected areas an effective tool (Boardman, 1981). However, over the past forty years, the validity of the concept of protected area is in crisis due to the excess of the conventional "conservation islands" (MacArthur & Wilson, 1967; Boardman, 1981; Farhing & Merriam, 1985; Romano, 2000, Rodrigues et al., 2004; Hoekstra et al., 2005). Moreover, a general acknowledgment of the negative effects on biodiversity caused by the landscape fragmentation has been registered (Soulé, 1986; Forman, 1995; Stanners et al. 1995 Forman, 1998; Cook, 2002; Bouwma et al., 2003; Jongman, 2004; Wiegand et al, 2005). At the same time, the emergence of theories on metapopulation (Levins, 1969), polarization of the landscape (Rodoman, 1974) and source-sink (Pulliam, 1988) have pioneered the conservation biology and the concept of landscape connectivity as tool to improve the vitality of the population and the species richness (Noss & Coperrider, 1994; Meffe & Carroll, 1997; Beier & Noss, 1998; Gilbert-Norton et al., 2010).

Thus, the concept of "ecological network" as a conservation network for the recovery and the maintenance of ecological connectivity and environmental continuity were introduced in the scientific debate (Levins, 1969; Noss, 1987; Simberloff, 1988; Dawson, 1994; Jongman, 1995; Forman, 1995).

The validity of scientific theory and the arguments behind this conservation strategy has been widely debated by scholars (Wilson & Willis, 1975; Diamond, 1975; Noss, 1987; Simberloff & Cox, 1987; Simberloff, 1988; Shafer, 1990; Hobbs, 1992, Simberloff et al., 1992; Dawson, 1994; Coperrider & Noss, 1994; Troumbis & Jongman, 1995; Beier & Noss, 1998; Haddad et al., 2000; Crooks & Sanjayan, 2006). In particular, the effectiveness of ecological networks, as tools able to maintain and improve landscapes and habitats spatially integrated, is increasingly accepted as an appropriate approach for the improvement of the ecological quality of natural ecosystems and for the biodiversity protection (Beier and Noss, 1998; Haddad et al., 2000; Van Rooij et al., 2003; Verboom & Pouwels, 2004; Smith, 2004; Damschen et al., 2006; Crooks and Sanjayan, 2006; Gilbert Norton et al., 2010). More recently, ecological networks tools are playing a central role landscape in planning (Opdam et al., 2006; Steiner, 2008), also taking into account an ecological and functional integration approach (Fichera et al., 2010; 2013).

Although identified in different ways, also depending on the reference spatial scale and priority goals, the constituent elements of an ecological network are: i) core areas, ii) corridors, and iii) buffer zones (Jongman, 1995; Bennett, 2004). Core areas are zones of high natural value for the conservation of habitats, species and landscapes. Although the criteria for their identification are not homogeneous, such areas may be divided into two main types (Biro et al., 2006): institutional natural protected areas (Boitani et al., 2003; Boitani et al., 2007); areas with particular characteristics (in terms of vegetation, size and spatial configuration etc.) suitable for the survival of certain species (Lambeck, 1997; Jetz et al., 2003; Watts et al., 2010). Corridors are physical connections between core areas so as to ensure the ecosystems self-regulation by allowing the movement of species. The corridors can be distinguished on the basis of: i) structure: continuous or discontinuous (stepping stones); ii) function (Foppen et al., 2000); and iii) characteristics that led to their identification (naturalness, biopermeability, etc.). Buffer zones are areas around the core areas or around the connecting elements, designed to protect network elements from exogenous disturbance originating from neighboring areas (Jongman, 2004; Oliver et al, 2008).

In their implementation, ecological networks can be classified according to three basic approaches (Fichera et al., 2013): i) physiographic approaches, centered on maintenance and strengthening of the spatial structure of the different existing ecosystems; ii) functional approaches, oriented to the management of ecological processes (than the regeneration of vital habitats for the target species that represent the local biodiversity); and iii) planning approaches, centered on a multifunctional planning perspective: ecological, recreational, aesthetic, etc.

These classical criteria are recently being integrated in the concept of green infrastructure (EEA, 2011), a complex and wide-ranging approach where ecological networks, as well as ensuring environmental features and the maintenance of biodiversity, are configured as guidelines for a proper ecological landscape planning.

3 ECOLOGICAL NETWORKS IN LANDSCAPE PLANNING

The construction and development of ecological networks (ENs) is one of the prominent strategies able to counteract the decrease of biodiversity level in contemporary landscapes (Hagen et al, 2012). According to Jongman et al (2004), ENs developed at different institutional levels have gained an increasing importance as possible common action in landscape planning towards nature conservation also in the context of European integration. Jongman et al (2004) report on EN projects managed in a number of European countries, from Portugal to Russia.

An EN consists of a system including a set of ecological punctual elements, often known as patches, (conceived as nodes) interlaced through a set of linear components, usually referred to as corridors (modeled as edges). The analysis of ENs can thus be referred to graph based modeling techniques that in the last decade have been extensively proposed under the terms complex network analysis (CNA). CNA applications are based on the wider availability in the last 15 years of large dataset and higher processing power. These techniques assist the analyst in the characterization of complex systems in many realms: biology, engineering, sociology, genomics, environmental planning, and others (for a review, see Barabasi and Albert, 2002). While many systems can be modeled by referring just to their topology, i.e. the purely logical relation between the nodes, ENs should be inspected by invoking the class of spatial networks. These networks include elements that present a clear and determinant reference to geographical space: in our case, nodes and edges consist of patches and corridors which display a certain location, extension, width, length, and shape (Dale and Fortin, 2010). The application of spatial networks to modeling ENs is still in its infancy and constitutes a promising field of application. Many studies (Adriansen et al, 2003; Bunn, Urban, and Keitt, 2000; Fall et al, 2007; Fortuna et al, 2006; Minor and Urban, 2007 and 2008; Pascual-Horta and Saura, 2006; Urban and Keitt, 2001; Urban et al, 2009) present similar approaches, as they include, inter alia: i) identification of the elements; ii) landscape connectivity analysis. Advanced spatial analysis is usually adopted to recognize and map ecological patches and corridors through the use of GIS tools including ad hoc routines tailored for network analysis and available in many software programs (Boyd and Foody, 2011; Gurrutxaga, Lozano and del Barrio, 2010; Marulli and Mallarach, 2005; Vuilleumier and Prélaz-Droux, 2002). Landscape connectivity analysis consists of the characterization of the EN, with a focus for establishing whether two given patches are connected or not. In this respect, meta-population, i.e. the study and identification of typical vegetal and animal target species, is of paramount importance (see, inter alia, Cartensen et al. 2012; Cartensen and Olsen, 2009; Hepcan et al, 2009; Kissling et al, 2012). Each species is defined by, inter alia, describing its general behaviour and, in particular, the attitude towards displacement. In this context, a very frequently adopted index is the dispersal distance, measuring the maximum length a certain target species is able to cover. In this sense, two patches are connected if they are located within the dispersal distance of target species, which are typical for the specific EN.

4 CASE STUDY: AN ECOLOGICAL NETWORK FOR NUORO

In this section, we apply a complex network analysis as a tool for the analysis and design of an ecological network for the town of Nuoro (henceforth, ENN), in central Sardinia, Italy. The argument unfolds in subsections as follows. In the first one, we introduce the main characteristics of the town of Nuoro. In the second, we focus on the choice of the target species and argue on the seed dispersal distances. In the third subsection, we report on the data elaborated and software adopted for modeling and analyzing the ENN.

4.1 GENERAL CONTEXT

The context of this application is Nuoro, which is a medium size (36,000 inhabitants in 2012, Istat www.tuttitalia.it) town located in central Sardinia. The history of the town reports on strong relationships between population and landscape, characterized, generally, by ecosystems belonging to the Mediterranean maquis and, typically, by fairly high altitude sites (maximum 955 m above sea level), such as the Ortobene urban mountain. The interplay between urban settlement and landscape is characterized by the absence of a clear boundary delimitating urban and rural settings. In this case, peri-urban areas play an important role in biodiversity management, because they are able to reconnect external environments to internal zones encapsulated in the urban fabric. The design and management of an ecological network would provide the municipality with a powerful tool for increasing the biodiversity level through connectivity policies. On the other side, urban and regional land use plans designed and approved by the municipal administration of Nuoro imply transformations which affect positively or negatively the ecological network. In this case, a coordination is required, as many examples of municipal ecological network indicate (Jongman et al, 2004).

4.2 TARGET SPECIES AND DISPERSAL DISTANCE

Olive (*Olea europaea* L.) and Holm oak (*Quercus ilex* L.) are two of the most characteristic plant species of peri-urban landscape of the town of Nuoro. Thus, they can be selected as vegetal target species for the EN of Nuoro. Olive is a peculiar component of the agricultural landscape by means of the cultivated variety (*O. europaea* var. *sativa*). Orchards are more or less traditional in the planting and managing system and the case of abandoned cultivations is present. Dissemination from cultivated plants may produce feral seedlings but also the wild variety (*O. europaea* var. *sylvestris*) is widely present in the peri-urban natural areas and may be active in the natural colonization of abandoned areas (Mulas, 1999; 2012; Mulas et al., 2002). Following the evolution of the vegetation cover, the affirmations of olive seedling generate the shrub or tree form of the species as component of the Mediterranean maquis (Mulas et al., 2001; 2005). Holm oak is the main component of most developed forests widely growing in the hills around the urban area of Nuoro. Moreover, the pure Holm oak forest is the climax natural vegetation cover of the Nuoro land hills (Mulas et al., 2004a). Olive and Holm oak frequently establish a natural equilibrium (Mulas et al., 2003). Olive is a colonizing species of burned or degraded soils by means of wild or feral seedlings. Seed spreading is highly efficient thanks to many birds or small mammalians (Mulas et al, 2003; 2004b). Seedlings slowly developed as bushes showing a fundamental function of soil protection and enhancing vegetation cover evolution. Olive bushes or trees also play a role in the affirmation of the subsequent colonization of Holm oak. This species, in fact, needs the shade of other bushes or trees and that is the case of the mature Mediterranean maquis. Because of the seed larger size and tender texture, the seedling spreading of Holm oak is less efficient than Olive. However, after colonization, Holm oak is very competitive with respect to other plant species and a significant reduction of biodiversity may be easily measurable in mature forests (Mulas et al., 2003).

ZONE	PATCH CLASSIFICATION	OLIVE (*OLEA EUROPAEA*)	HOLM OAK (*QUERCUS ILEX*)
Peri-urban	1) Natural area or rangeland	Absent	Absent
	2) Olive orchard	Dominant as cultivated or abandoned tree	Absent
	3) Natural area or rangeland	Present as initial colonization by seedlings	Absent
	4) Natural area or rangeland	Affirmed as shrub component of maquis	Absent
	5) Natural area or rangeland	Affirmed as shrub and tree	Present as initial colonization by seedlings
	6) Pure or mixed forest	Absent	Present or dominant as mature tree
Urban	7) Abandoned area	Present or potentially colonizable area	Absent
	8) Natural area/green area	Affirmed as shrub component of maquis or urban green	Absent or present as young plants
	9) Natural area/green area	Absent	Present or dominant as mature tree
	10) Corridors	Street trees, way borders and other forms of natural communications.	Street trees, way borders and other forms of natural communications.

Tab. 1 Possible classification of land plots to support the patches and corridors establishment

Both Olive and Holm oak are widely used in the urban and peri-urban green areas both artificial (gardens and street trees) or natural (abandoned orchards, parks, and unused areas). Thereafter, the choice of those two species allows the classification of urban and peri-urban areas based on the potential colonization, presence and evolution of them. The land analysis may be also structured as ecological network by definition of patches, natural corridors and relative connections, thus measuring the possibility of relationship between urban and peri-urban areas in terms of plant species colonization and evolution. Consequently, the functionality of peri-urban areas with respect to plant cover evolution and as potential receptors of plant colonization from urban sources may be evaluated.

With the aim to analyze this potential network system and to elaborate a corresponding functional model a first definition of potential patches and corridors was designed and presented in Table 1. This is a minimal systematic key of land description proposed for the first step of the soil cover classification.

The most active seed dispersal vector of the Holm oak seeds is the European jay (*Garrulus glandarius*) (Gomez, 2003; Pons and Pausas, 2007). The average dispersal distance of the bird is 250 m, with a recorded maximum of 1000 m (Table 2). Less effective as seed dispersers are the rodents, with some different species like woodmouse (*Apodemus sylvaticus*) and garden dormouse (*Eliomys quercinus*) (Gomez et al., 2008). Rodents are also active in the seed dispersal of Olea europaea but the maximum dispersal distance of these vectors is of few meters. More efficient as olive seed disperser are many frugivorous birds, like Common Starling (*Sturnus vulgaris*), Song Thrush (*Turdus philomenos*), Blackcap (*Sylvia atricapilla*), Sardinian Warbler (*Sylvia melanocephala*) (Rey et al., 2000; Alcantara and Rey, 2003). The most probable maximum distance of seed dispersal by these birds is of 100 m because they swallowed olive fruits whole, regurgitating the stones 20-50 min later (Bass et al., 2006). Wild big mammalians and livestock, like pigs, sheep, goats and cattle, feed both Holm oak and Olive seeds. However, these vectors efficiently disperse only olive seeds. In addition, the European fox (*Vulpus vulpus*) may be a possible disperser of olive seeds for a maximum distance of 50 km (Bass et al., 2006).

VECTOR SPECIES	OLIVE (*OLEA EUROPAEA*)	HOLM OAK (*QUERCUS ILEX*)
Jay (*Garrulus glandarius*)	Unknown	1000 m
Common Starling (*Sturnus vulgaris*); Song Thrush (*Turdus philomenos*); Blackcap (*Sylvia atricapilla*); Sardinian Warbler (*Sylvia melanocephala*);	100 m	Unknown
Rodents: woodmouse (*Apodemus sylvaticus*); garden dormouse (*Eliomys quercinus*)	7.5 m	7.5 m
Sheep (*Ovis aries*), goat (*Capra aegagrus hircus*), cattle (*Bos taurus*), pig (*Sus scrofa*)	2000 m	Unknown
Fox (*Vulpus vulpus*)	50 km	Unknown

Tab. 2 Maximum seed dispersal distance of the most active animal vectors

Because of this knowledge, we can suppose that the two plant species have multiple possibilities to be efficiently dispersed in the peri-urban area, where big mammalians are mostly active, and a reasonably restricted viability in the urban zone. The highest spreading possibility are for Olive species that in spite of the minor dispersal distance (maximum 100 m) is favoured by the high population of active frugivorous birds. On the contrary, the Holm oak showed a potential wider spreading area (maximum 1000 m range) but a decidedly lower population of animal vectors and a strongest dependence from ecological corridors.

3.3 DATA AND SOFTWARE USED

The construction of the ecological network of Nuoro has implied the identification and classification of patches in a pilot area of the town. Geographical information has been drawn from the aerophotogrammetric map of the municipality of Nuoro and verified through photo-interpretation and further field survey. We refer to the ortophoto of Nuoro geo-referenced with Gauss-Boaga coordinates and released in 2006 by the Autonomous Region of Sardinia (ARS). In addition, we have considered the information contained in the Sardinian Forestry Plan, District level, regarding the town of Nuoro. Land use planning information has been extracted from the municipal master plan (official Italian name and acronym: Piano Urbanistico Comunale, PUC) of the town of Nuoro. In Table 3, metadata of the information processed is reported.

DESCRIPTION	FORMAT	SCALE	RESOLUTION	YEAR	SOURCE
Aerophotogrammetric map of Nuoro	AutoCad drawing (*.dwg)	1:10000	—	1998	ARS
Orthophoto	*.Geotiff	—	0.50mx0.50m	2006	ARS WMS free service
Piano Forestale Ambientale Regionale	*.pdf	—	—	2007	ARS
PUC of Nuoro	*.shp	—	—	1980	Province of Nuoro

Tab. 3 Metadata of the information processed for building the ecological network of Nuoro.

Geographic information has been processed through CAD proprietary software (Autodesk AutoCad) and GIS open source software (QGIS). Spatial network visualization and analysis has been performed through the open source software Ghephi (Bastian, 2009).

The narrative of this paper continues in the other homonymous paper “Part B”.

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LANDSCAPE PLANNING AND ECOLOGICAL NETWORKS

PART B

A RURAL SYSTEM IN NUORO, SARDINIA

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ABSTRACT

This paper represents the continuation, i.e. Part B, of an homonymous paper aiming at designing an ecological network for the periurban area on the town of Nuoro in central Sardinia. While in Part A we illustrate the methodological premises and introduce a spatial network analysis-based study of a pilot ecological network, in this paper we apply a complex network analysis approach to the construction and characterization of the dynamics of the ecological network of Nuoro.

We are interested in monitoring the performance of the ecological network evolving from a real to a hypothetical scenario, where the two target vegetal species (holm oak and cultivated or wild olive) are present in each patch. We focus on global network properties and on three different centrality measures: degree, clustering coefficient, and betweenness centrality. We also take into account the influence of the intensity of the connection (i.e. the weight) by introducing the corresponding weighted centrality measures. Through thematic mapping we illustrate the pattern of each centrality indicator throughout the entire pilot set of patches. In this way, we demonstrate how spatial network analysis is useful to monitor the performance of the network and to support decision-making, management, and planning.

KEYWORDS
Spatial network analysis, dynamics, centrality, monitoring system

1 INTRODUCTION

This paper represents the continuation of another paper titled "Landscape planning and ecological networks. Part A. A rural system in Nuoro, Sardinia", where we have presented the premises of a study on the ecological network in Nuoro (ENN), Sardinia. In this paper, we illustrate the applied methodology to build the ENN. We analyze the ENN and comment on the obtained results.

2 BUILDING THE ENN

The study has regarded the northern part of Nuoro where we have sampled a set of 100 patches (nodes in the ENN). Each patch has been characterized according to the classification proposed in Table 1, where we report the classification for ten characteristic patches.

N	CLASSIFICATION	OLEA EUROPEA	QUERCUS ILEX
1	Olive orchard	Dominant cultivated	Absent, possible colonization
2	Green area	Present cultivated	Absent, possible colonization
3	Green area	Absent, possible colonization	Present as young plants
4	Green area	Present cultivated	Absent, possible colonization
5	Green area	Present cultivated	Established
6	Green area	Present cultivated	Established
7	Green area	Absent, possible colonization	Established
8	Green area	Absent, possible colonization	Established
9	Green area	Absent, possible colonization	Established
10	Natural area	Initial colonization	Absent, possible colonization

Tab. 1 General characterization and classification of the first ten patches of the sample.

The information was collected through analysis of orthophotos, validated on site and has been then processed in an integrated GIS-network modelling environment. The ENN is composed of a set of nodes *N* - each one corresponding to the centroid of a patch - and a set of edges *E* representing the dispersal relational connections between patches. Two patches are connected if their centroids lay within a certain dispersal distance. Centroids correspond to the geometric barycentre of each patch thus two patches are connected in the ENN depending on the geometry of their areas: small patches are much more likely to be interconnected than larger ones.

We use time-varying analysis of the ENN to monitor its characteristics over time. In this case, we study the dynamics of the ENN in order to build a monitoring system of that network.

Relevant benchmarks in the ENN's dynamic analysis consist of an initial and a final scenario. The initial scenario is represented by the network configuration ENN_{2014}, where patches are included as nodes, only if they currently host target species. The final scenario corresponds to a network configuration ENN_{FIN} which is the composition of two ecological networks ENN_{FIN_OLEA} and $ENN_{FIN\_QUERCUS}$, where the two target species are present in all the patches. We assume that the final scenario corresponds to the configuration requested by citizens and public administration interested in boosting policies against the loss of biodiversity and vegetal biomass (carbon sink). In addition, we consider that the final scenario is the result of a process where exogenous (human) actions intervene in the network development with programs, plans, policies, etc., in order to implement urban and peri-urban green infrastructures.

We are interested to model an ecological urban systems as a network of relational properties between nodes. We mathematically formalize our model through the adjacency matrix A, where diagonal elements a_{ii} are equal to zero (no self-loops are admitted: a patch can not be connected to itself) and off-diagonal elements a_{ij} are equal to 1, if nodes *i* and *j* are connected, and 0 otherwise. In addition, we represent the ENN as weighted directed spatial networks in order to take into account: i) the pattern of seed dispersal from colonized to first neighbour nodes, and ii) the intensity of the relation between each pair of nodes. In this respect, we consider that the intensity of interaction (i.e. the weight) varies depending on the probability that the seeds are dispersed and the impedance to movement. According to the ethologic studies reported in section 3.2 of Part A, olive seeds are dispersed with a probability that is 200 times higher than the corresponding measure for Holm oak seeds. In this first application, we model impedance as the inverse of the distance between patches' centroids. Thus, we model the level of interaction between patches (link weights) colonized by both the two target species according to the following equation:

$$w_{ij} = (p_o + p_q) * \frac{1}{d_{ij}} \tag{1}$$

Where p_o is equal to 0.05 and p_q to 1 representing the dispersal level of Olea Europea (p_o) and Quercus Ilex (p_q); d_{ij} is the Euclidian distance between the centroids of patches.

In Figure 1, we illustrate the ENNs corresponding to the initial (on the top) and final (on the bottom) scenarios. Spatial weighted networks overlay the orthophoto of Nuoro. Nodes are identified by the red dots; weights are thematically represented in different colour and thickness.

In the next section, we scrutinize the two network scenarios.

3 ANALYZING THE ENN

This section presents the network analyses developed for the two scenarios of the ENN. We divide the illustration in two parts; the first part is dedicated to the analysis of the topology of the EN, while in the second one we focus on the weighted network study. In table 2, we report the main topological measures calculated for the two scenarios.

The first five columns of Table 2 describe simple network characteristics, such as number of nodes (N) and edges (E), edge density (E/N), average shortest path length (<l>), and diameter or maximum path length (l_{max}). While the number of nodes is constant, the number of edges reaches more than the double of the original value. The same behaviour holds for the density. The average shortest path length, a measure of cohesiveness among the nodes, is low signalling high interconnectivity in the ENN. We observe a decrease of 2% of the average shortest path, while the diameter decreases of 20%.

The last three measures of Table 2 represent a synthetic indication of different aspects of network centrality. Nodes with a high centrality play a crucial role in the entire architecture of the system, whose overall vulnerability depends on the those fundamental elements. In detail, the different centrality measures unfold as follows. The degree k represents the number of connection of a node with the first neighbours.

The ENN is a directed network where we can account for incoming connections (in-degree, Kin) and, outgoing connections (out-degree, Kout) from a given node. In an ecological network, the degree represents the probability of a patch to be colonized (in-degree) and colonize (out-degree) other patches.

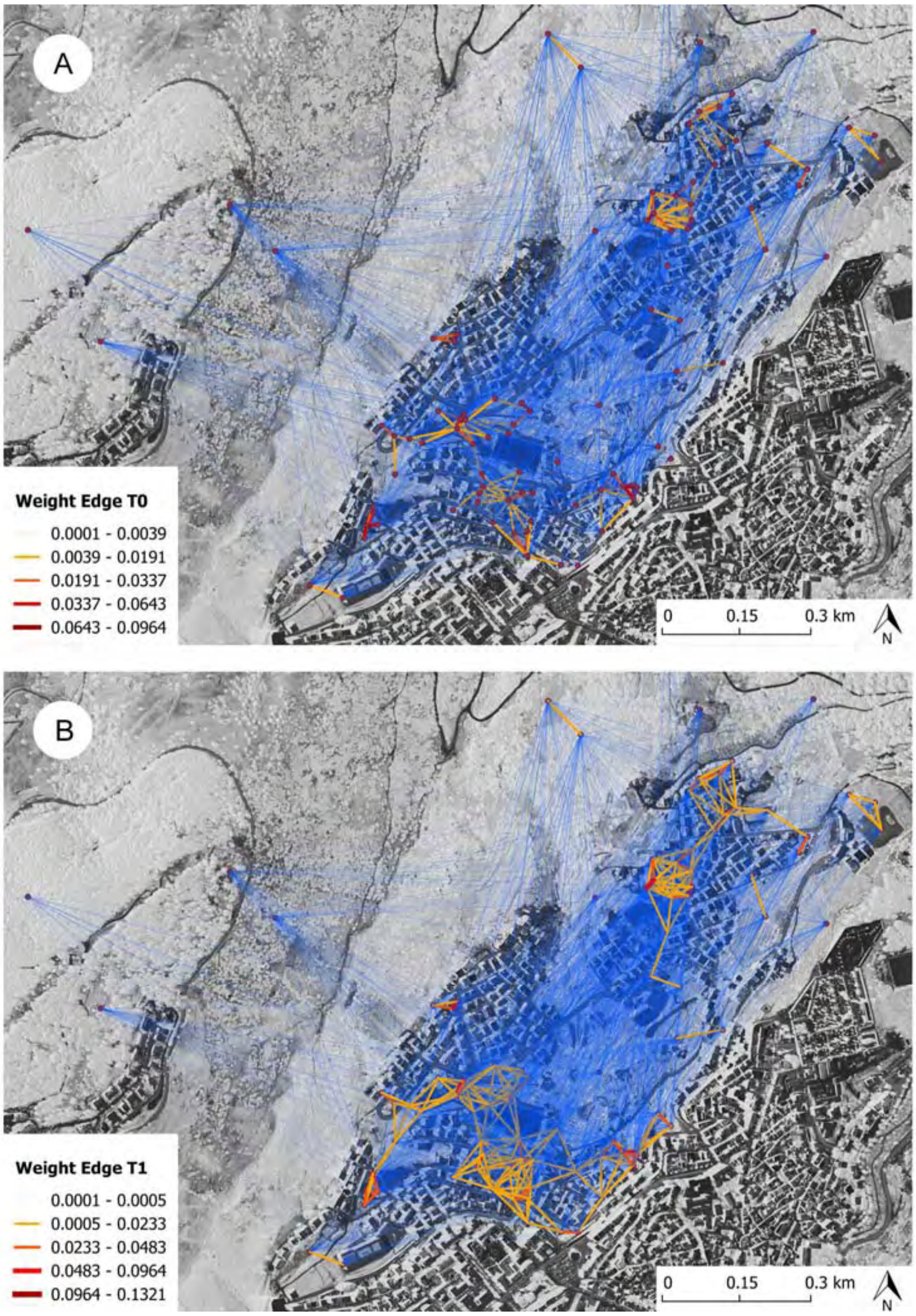

Fig. 1 The Ecological Network of Nuoro (ENN): spatial weighted network representation of initial (A) and final (B) scenarios.

SCENARIO	N	E	E/N	<l>	l_{max}	<Kin>	<Kout>	<C>	<BC>
Initial	100	3677	36,77	1,35	5	37,14	61,28	0,648	0,0019
Final	100	7948	79,48	1,32	4	79,84	79,84	0,934	0,0034

Tab. 2 Topological analysis of the ENN: initial and final scenarios.

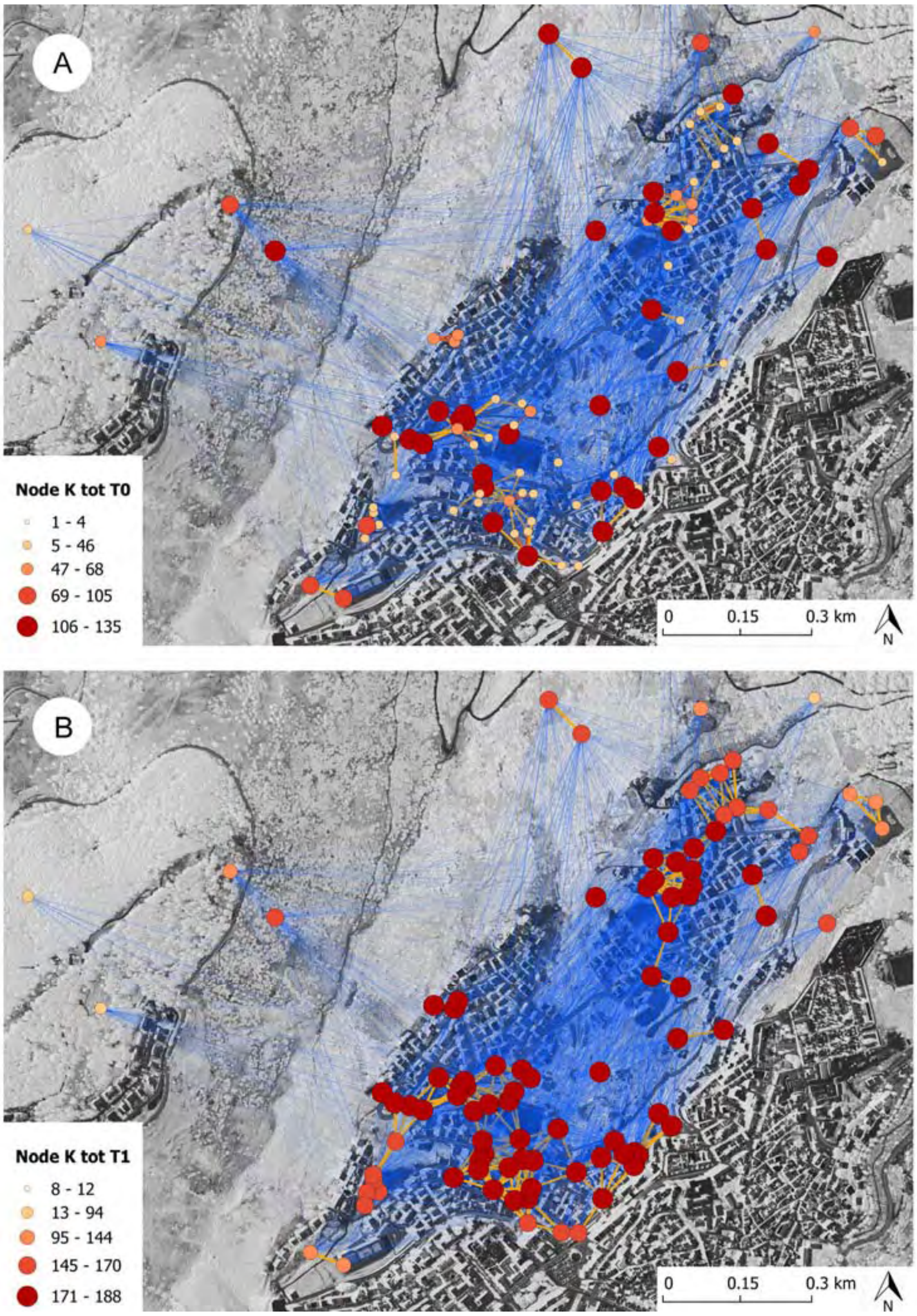

Fig. 2 Thematic mapping of total degree (K tot) for initial (A) and final (B) scenario.

The average values of Kin and Kout increases between the two scenarios although Kin roughly doubles. In Figure 2, we map the sum of Kin and Kout, the total degree (K tot): this analysis points out immediately the most and less connected patches of the ENN.

The node clustering coefficient (CC) is another network measure able to represent the level of interconnection between nodes that are connected to a given node. This coefficient ranges between 0 - completely disconnected- to 1 for completely connected neighbours.

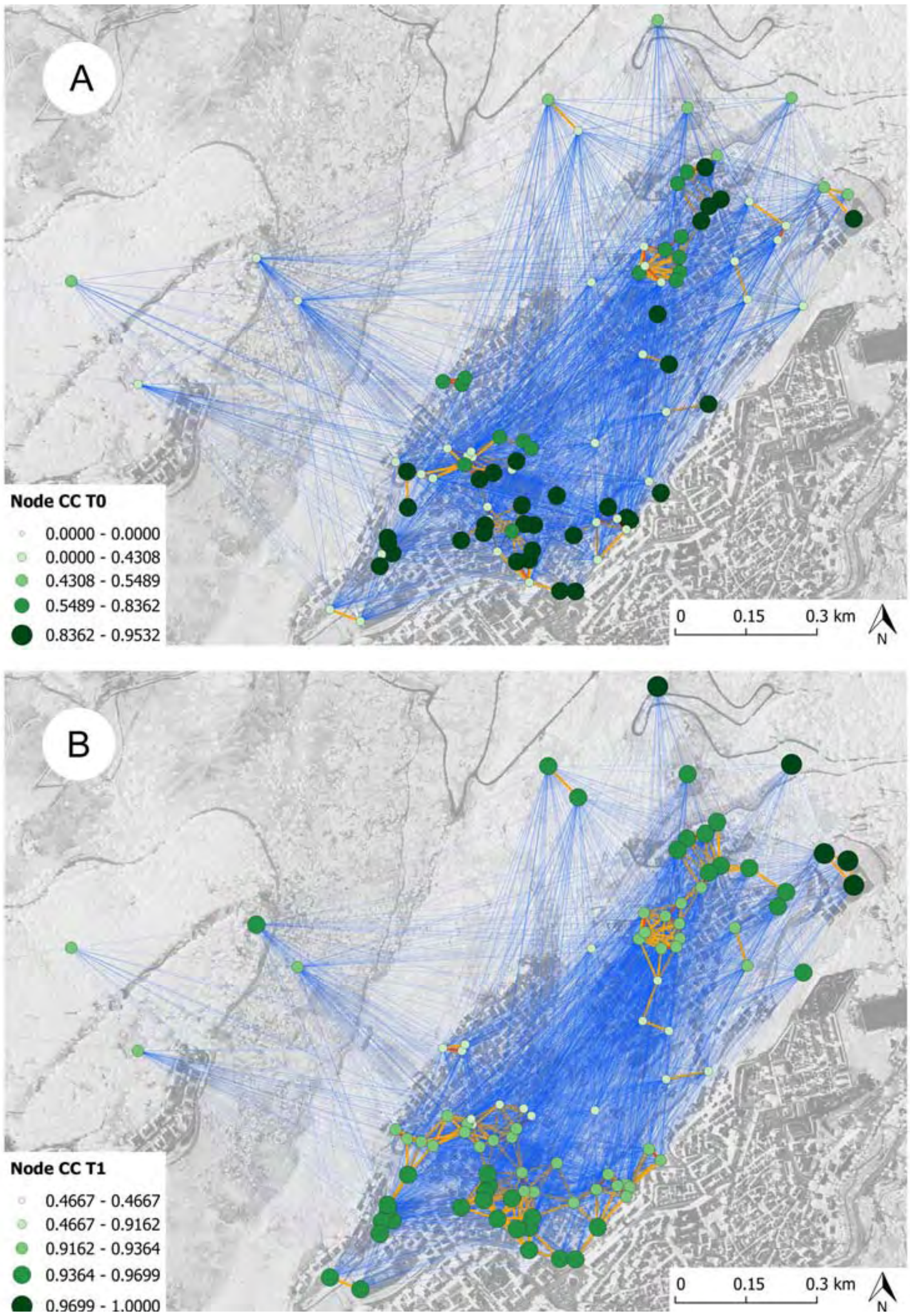

Fig. 3 Thematic mapping of the Node Clustering Coefficient (CC) for initial (A) and final (B) scenario.

In our case, this measure shows a remarkable growth and is close to 1 in scenario B. In Figure 3, we map the node CC for the ENN in the initial (T0) and final scenario (T1). Finally, the node betweenness centrality (BC) is another indicator of inter-centrality, as it measures the number of shortest paths connecting two nodes whatsoever and passing through a given node. Thus, BC is able to detect the patches that act as bridges and provide the shortcuts in the ENN. The average BC nearly doubles the initial in the final scenario. In Figure 4, we map the BC in the initial (T0) and final scenario (T1).

The second part of the analysis is based on a weighted network study of the centrality. In table 3, we report the main measures obtained in this analysis.

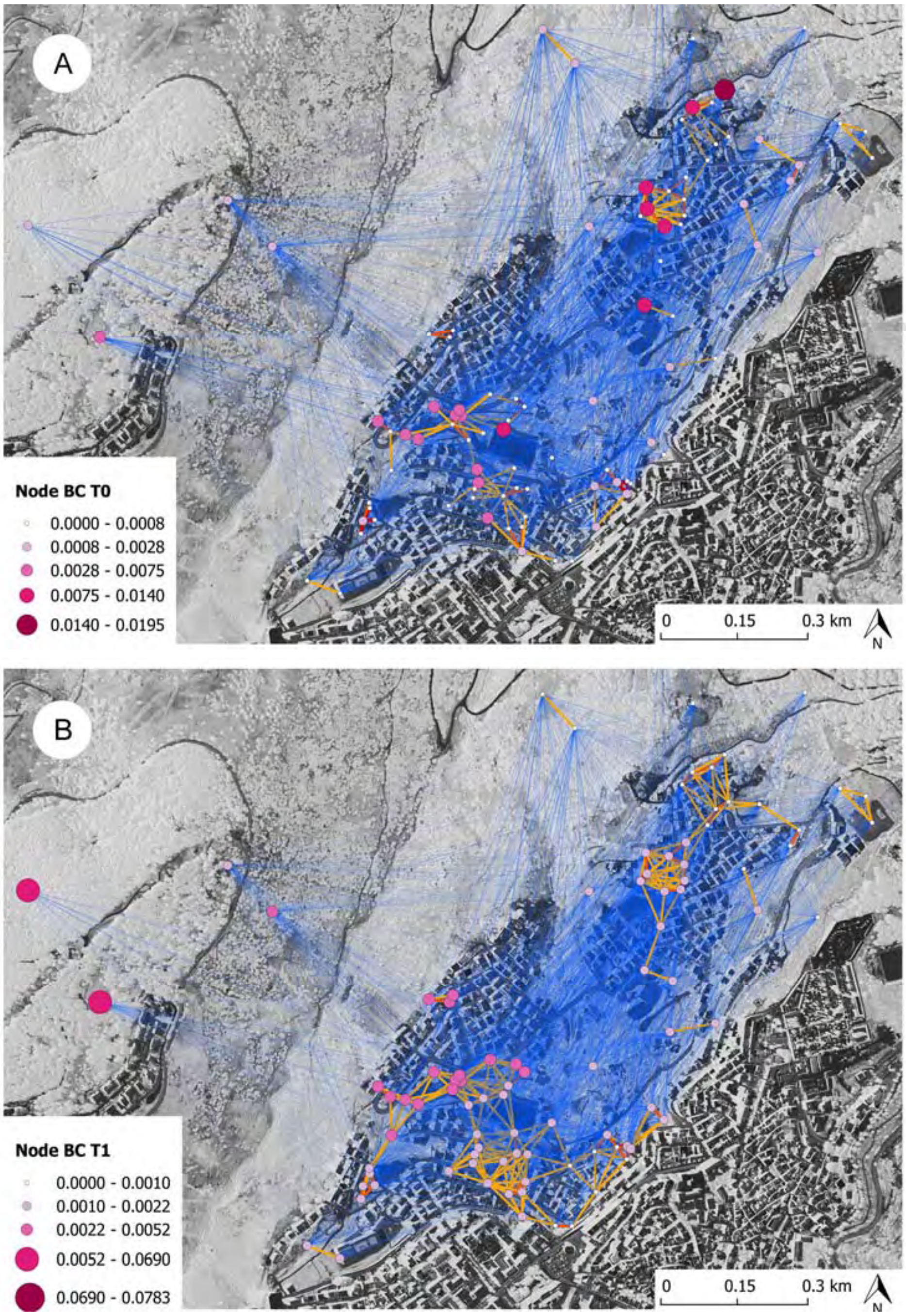

Fig. 4 Thematic mapping of node Betweenness Centrality (BC) for initial (A) and final (B) scenario.

The weight holds the intensity of the connection between patches. The average values increases, a sign that overall connections become more reliable and colonization possible.

The strength (S) can be interpreted as weighted total degree, as it measures the sum of the weights associated to the edges of a given node.

This indicator is able to appreciate the centrality of a node with respect also to the "traffic" implied. In our case, the quantity transported is the number of seeds dispersed in the ENN from or to a given patch. On average, the strength displays a relevant growth reaching a figure that is by far more than the double of its original value.

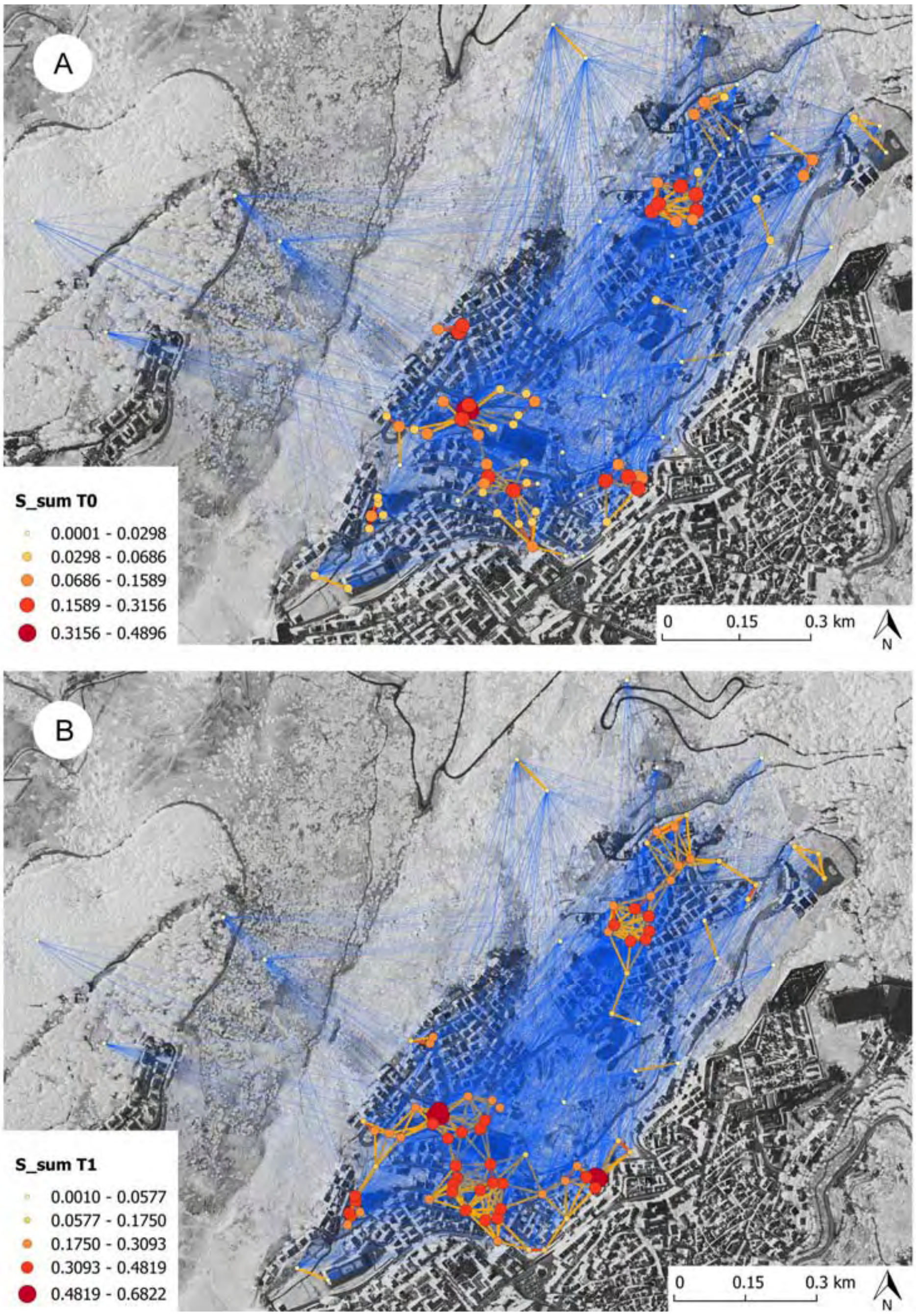

Fig. 5 Thematic mapping of the strength (S_sum) for initial (A) and final (B) scenario.

SCENARIO	<w>	<s>	$<C_w>$	$<BC_w>$
Initial	0.0010	0.08	0.002	0.004
Final	0.0014	0.22	0.002	0.011

Tab. 3 Weighted network analysis of the ENN: initial and final scenarios.

In Figure 5, we map the strength throughout the whole ENN (S_sum) in the initial (T0) and final scenario (T1). The node weighted clustering coefficient (CCweight) yields an appreciation of the level of connectedness between neighbour nodes taking into account the intensity of the connections.

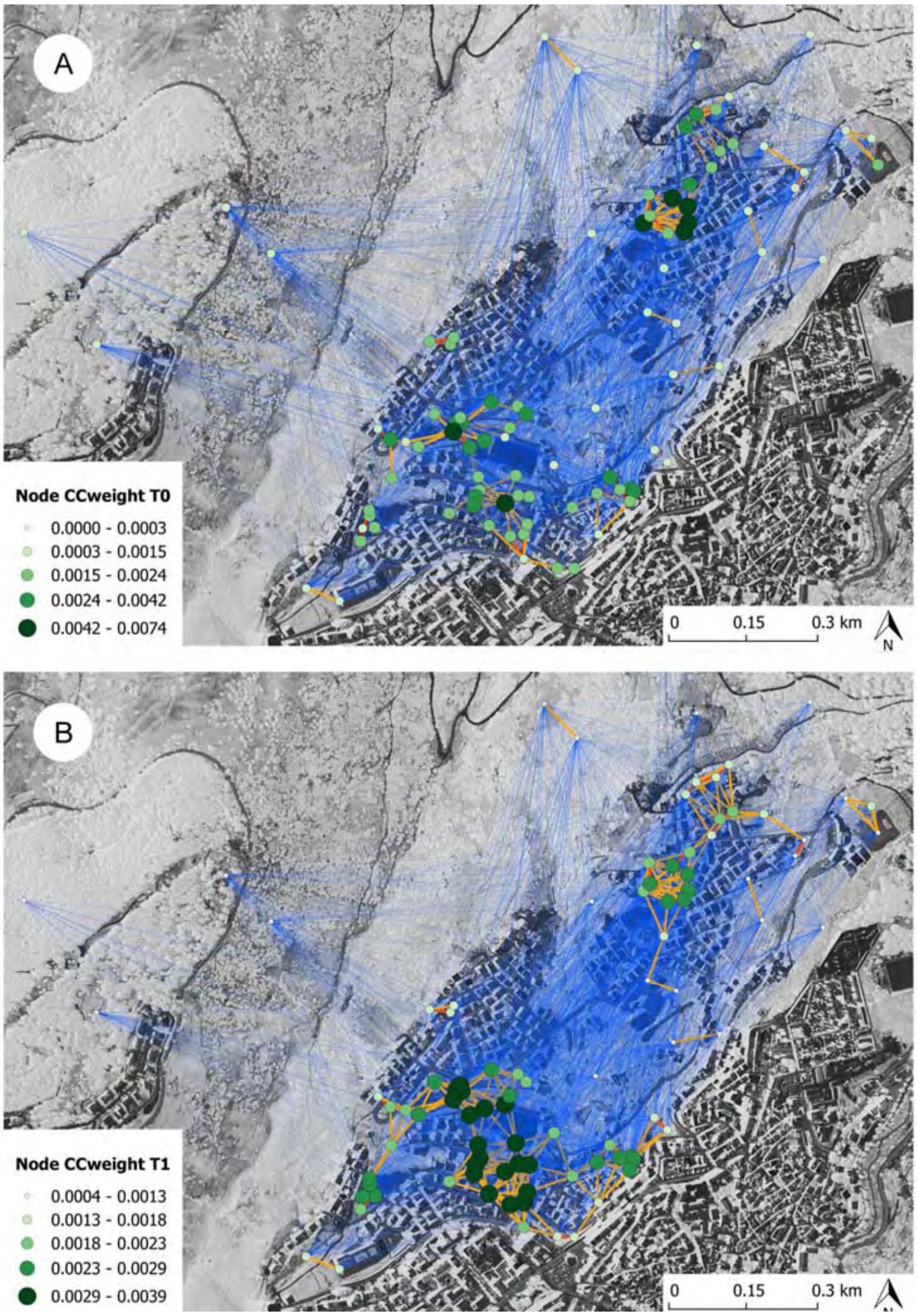

Fig. 6 Thematic mapping of the node weighted clustering coefficient (CCweight) for initial (A) and final (B) scenario.

This measure on average does not show appreciable variations. In Figure 6, we map CCweight throughout the whole ENN in the initial (T0) and final scenario (T1). The node weighted betweenness centrality (BCweight) is a measure able to describe the level of inter-centrality taking into account the influence of the intensity of the connections. On average this indicator displays a significant increase. In Figure 7, we map BCweight throughout the whole ENN in the initial (T0) and final scenario (T1).

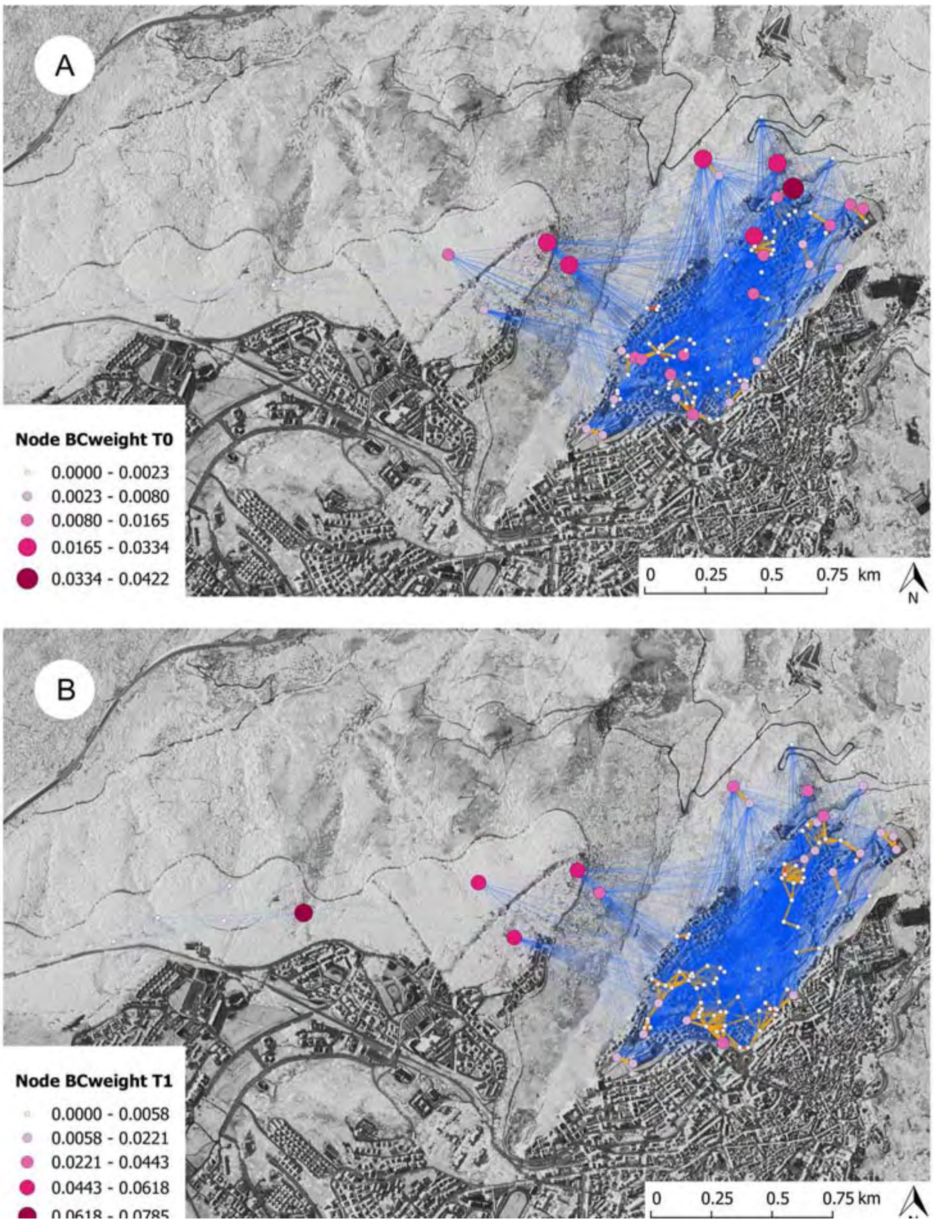

Fig. 7 Thematic mapping of the node weighted betweenness centrality (BCweight) for initial (A) and final (B) scenario.

4 CONCLUSION AND OUTLOOK

In this section, we summarize the argument developed in the two papers (Part A and B) regarding the study of an ecological network of Nuoro, Sardinia, and propose possible courses of future research. In these essays, we start by recalling the major research streams attaining biodiversity conservation, which includes, inter alia, the design, construction, and maintenance of ecological networks. We have presented the approach to ecological network in landscape planning and recalled fundamental concepts, such as target species and dispersal distance, that have allowed us to describe the main determinants of the dynamics of an ecological network, i.e. the colonization of new green areas or patches. We have connected the analysis of these issues with research on spatial networks, in order to interpret the ecological network as a system. Green areas (i.e. nodes) represented by the patches' centroids (barycenters) are interlaced by connections describing the probability of mutual colonization. We have built the ecological network on a pilot set of 100 patches connected according to the spatial distribution and dispersal pattern of two target species: the Olea Europea and Quercus Ilex. We have applied spatial network analysis to monitor the dynamics of the ecological network evolving from an initial to a final scenario. The initial scenario corresponds to the current situation, while the final scenario to an ideal network, where all the patches host both the target species. This analysis focuses on global characteristics and on the centrality of the patches assessed through three measures: degree, clustering coefficient, and betweenness centrality. These indicators are able to locate the most critical patches providing the whole system with informational resistance and shortcuts.

This study presents robust premises that merge biodiversity conservation issues, ecological network management and planning, and spatial networks analysis, while reports on an application to the case of Nuoro which is still on a pilot stage. Thus our research needs further work on some questions we now argue on as follows. The extension of the pilot system currently covers the northern sector of the town of Nuoro including just one hundred patches. We are going to extend our analysis to the whole municipality comprehending both urban and periurban areas. We have included patches by detecting the presence of target species through mainly two instruments: field survey and orthophoto interpretation. As the first is always the most reliable assessment of current status of the patches, we would like to verify every patch colonization status through direct field work. Another set of questions attain the ecological network construction and analysis. We have established the connection's intensity by imposing, in first approximation, that the weight is proportional to the inverse of the distance between two patches. In this way, we take into account that the dispersal through short distances is easier than through longer distances. We feel further investigation is needed to better specify how distance, as well as other elements, such as the extension of the patches, affect seeds' dispersal and to construct a finer model to describe the weights. In addition, we have adopted network centrality measures to describe the criticality of some patches with respect to others. Further research is needed to clarify the meaning of these measures with respect to the underlying ecological principles. Finally, spatial network tools have been developed in the perspective to build an efficient decision and planning support system. Many planning tools affect the development and performance of the ecological network of Nuoro: the main tool is the Municipal Master Plan, which regulates land use. Further work is in need to study the characteristics of planning tools, the most critical parts, and the transformations implied in perspective to ascertain how a municipal ecological network evolves.

IMAGES SOURCES

Figg. 1-7: All the pictures have been realized by Amedeo Ganciu and post-processed by Antonio Ledda.

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SEA GUIDELINES

A COMPARATIVE ANALYSIS: FIRST OUTCOMES

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ABSTRACT

The European Directive 2001/42/EC (Directive) has introduced the Strategic Environmental Assessment (SEA), a procedure for assessing the effects of certain plans and programs on the environment. The Directive has been transposed in different ways and times within Europe: member states have frequently drawn up guidelines to facilitate SEA implementation, by adopting different approaches. So far a few studies have been performed to analyze SEA guidelines.

In this paper we aim to analyze key elements of SEA guidelines released by seven European countries in order to evaluate the effectiveness of those documents and SEA implementation. We have found that no SEA guidelines satisfy all key elements we have identified. Based on the latter finding, this work is introductory to a further analysis which aims to characterize SEA guidelines and define a proposal of SEA guidelines for landscape planning in the Italian region of Sardinia.

KEYWORDS

Strategic environmental assessment, European Union, Guidance documents

1 INTRODUCTION

Italy has acknowledged the European Directive 2001/42/EC (Directive) through the legislative decree 152/2006 (Italy 2006), henceforth Environmental Code, which has been subsequently improved by similar legislative decrees in 2008 and 2010 (Italy 2008, 2010).

The degree of SEA implementation within the Italian context has been unequal: good experiences of SEA have been documented mainly in the northern regions of the peninsula (De Montis 2013), but in Southern Italy and, in particular, in Sardinia some difficulties in SEA practice have been documented at the level of municipal spatial planning (De Montis *et al.* 2013). Therefore, there is the need of documents able to steer SEA practice towards the achievement of homogeneous higher quality level. Many countries have so far adopted such documents under a variety of denominations like guidelines, guidance or manuals (henceforth SEA guidelines). With respect to Italy, SEA guidelines have been drawn up in the context of EU Structural Funds 2000-2006 (Italy 1999) and of the Enplan Project (Enplan Project 2004).

The aim of this paper is to scrutinize the guidelines approved by some European countries in order to evaluate the effectiveness of those documents and SEA implementation. We focus on critical points, in the perspective of the design of specific guidelines on SEA implementation in Sardinia for the sector of spatial planning. The study is not intended to establish a ranking or quality benchmarks. It regards instead the relevance of each guideline with respect to issues reported as relevant in the literature. This work has been carried out in three steps: i) literature review on the classification criteria about the structure of the guidelines; ii) identification and selection of guidelines available on-line; iii) comparison of the contents of the selected guidelines with respect to the classification criteria. The arguments of this paper unfold as follows. Section 2 reports the literature review about SEA guidelines, and introduces the key elements emerging in those documents. In Section 3, we explain our classification methodology. In Section 4, we present the results, which are discussed in Section 5. In Section 6, the final conclusions are presented.

2 SEA GUIDELINES CRITICAL ISSUES: A LITERATURE REVIEW

Despite a fairly good practice in the adoption of SEA guidelines, so far only a few studies have scrutinized the effectiveness of those documents. Schijf (2011, 487) argues "that there has been little systematic analysis of the guidance that is available". In this section, we discuss some critical issues emerging from SEA implementation in different contexts, and from drawing up SEA guidelines.

The choice of a particular SEA process depends on the context and level of the policy, plan or program (PPP). At the policy level, it may be appropriate to make a low detailed qualitative assessment. With respect to the evaluation of plans or programs, direct environmental effects are involved and an EIA-based procedure may be invoked (Abaza *et al.* 2004, 93). The availability of SEA guidelines drawn up for specific sectors, organizations, and types of impacts, is useful to promote, or speed up, SEA practice (Thérivel 2004, 208). Schijf (2011, 491) argues that there are good reasons "for making specific guidance material to a given planning system, a certain planning level or particular type of policy, plan or programme" and there are "also solid reasons for developing sector-specific guidance on SEA". Brown and Thérivel (2000) argue that SEA methodology "have to be shaped according to the PPP formulation and decision-making context" and the "techniques, processes, time frames and administrative requirements for implementing SEA need to be tailored closely to the particular circumstances of the PPP under consideration". SEA methodologies are related to issues like "the level at which PPP formulation and decision-making occurs" (Brown and Thérivel 2000), and none of them is directly applicable to any socio-political context or strategic action. Balfors and Schmidtbauer (2002) examine the Swedish SEA guidelines for EU Structural Funds, which "aim to increase

the integration of environmental concerns in the programming process by promoting the application of environmental-objective-led SEA". The guidelines document, developed by the Swedish Environmental Protection Agency, covers different themes ranging from a description of the Structural Fund system to International regulations about sustainable development, from the "SEA as a tool that can provide the programmes with an environmental profile" to "a substantial section on good examples of environmental integration [...]". Balfors and Schmidtbauer (2002) argue that "to achieve a successful implementation of the guidelines, supporting strategies may be needed" which consist, for example, in educational strategies. Diamantini and Geneletti (2004) analyze implementation of SEA in the Autonomous Province of Trento (APT), Italy, where "guidelines to carry out the environmental report [...] were issued and experimentally applied to several sectoral plans", emphasizing both the positive aspects and shortcomings affecting the guidelines and their application. To check how the guidelines were applied in practice, the APT's Mobility Plan was used. According to the authors, a major concern in SEA implementation of a sector plan is the absence of references to a sustainability framework, because that SEA might just be restricted to "a limited subset of environmental issues and indicators, disregarding the synergies and cumulative impacts of concurrent plans". Sheate *et al.* (2004) provide an overview on the implementation of the SEA Directive in the UK with respect to three key issues: legal framework, plans and programmes interested, and the provision of support to practice, like guidance. Sheate *et al.* (2004, 77) list a number of SEA guidance documents in some sectors, and acknowledge that: "[a] key challenge for implementation in practice will be in providing guidance and training appropriate to different sectors, which have their own different traditions, expertise and experience (or not) of strategic forms of assessment".
Brooke et al. (2004) develop on how SEA effectiveness can be maximized in South West England, where some experience has already been gained in the context of both environmental impact assessment (EIA) at project level and sustainability appraisal of regional and local land-use plans. Brooke et al. (2004, 142) points out that it is need to think in different terms than the project EIA, in order to consider the strategic aspects typically related to plans and programmes, adding that "[i]t is likely that different methods will be useful for different types of plan and this will need consideration in any guidance issued on methods for SEA".
Other authors have analyzed SEA guidelines in different sectors, in the European and international context. Donnelly *et al.* (1998) provide a summary on Impact Assessment Guidelines, by including a range of evaluation procedures: EIA, cumulative effects assessment, environmental health impact assessment, risk assessment, social impact assessment, and SEA. Donnelly *et al.* (1998) overall cite "[...] over 800 bibliographic references and abstracts for more than 90 countries and 45 international development agencies". Thérivel *et al.* (2004) discuss guidance documents drawn up in some countries (as England, Iceland, Scotland, and so on) and highlights specific unresolved issues regarding: i) the application to other types of plans and programmes; ii) consultation; iii) and resourcing SEA, given that SEA practice requires considerable financial and human resources and a lack of them can affect the practical application of the recommendations proposed by the guidelines. Fischer (2007, 109) identifies and reviews over 40 guidelines. Finally, Schijf (2011) lists a number of considerations, suggestions and tips, mainly based on practical experience and opinions of SEA professionals involved in drafting of SEA guidelines, to design and draft guidance documents of good quality.

3 CLASSIFYING GUIDELINES: A METHODOLOGY

Our literature review has found few studies about drawing up effective SEA guidelines. We have selected the classification criteria as reported in Table 1.

	CLASSIFICATION CRITERIA	REFERENCES
A	Specific guidelines	Brooke et al. (2004); Sheate et al. (2004); Thérivel (2004); Schijf (2011)
B_1	Regularly updated	Schijf (2011)
B_2	Case studies included	
B_3	Availability on-line	

Tab. 1 SEA guidelines: classification criteria and references

The first criterion (A) is relevant in guidelines which refer to SEA implementation in given sectors or contexts. Some authors argue this criterion regards SEA guidelines that are too generic and do not take into account the hierarchical (policy, plan, or program) level (Schijf 2011) or sector of SEA implementation (Brooke *et al.* 2004; Sheate *et al.* 2004; Thérivel 2004; Schijf 2011). The second criterion (B_1) concerns periodic updating of SEA guidelines to adapt to changes over time of the local context and "follow the evolution of planning and SEA experience within a given system" (Schijf 2011). The third criterion (B_2) takes into account if real case studies have been included in SEA guidelines, as they "make SEA process more tangible [...]" (Schijf 2011), and provide lessons for practice. Another useful criterion (B_3) attains the availability of SEA guidelines on the World-Wide-Web such as in the case of, for example, the Hong Kong SEA Manual (Hong Kong 2007; Schijf 2011). Finally, Schijf (2011) considers the length (number of pages) of SEA guidelines, because those guidelines particularly long may be unattractive and tiring to read (see Tab. 3). However, this element may be assessed as too subjective, in our view, given that too brief SEA guidelines may provide poor guidance or it could be inefficiently structured; therefore, we decided to consider it separately with respect to the other key elements.

4 APPLICATION TO A SELECTION OF SEA GUIDELINES

In this section we apply the classification presented in section 3 to the analysis of a sample of SEA guidelines. The arguments unfold in two subsections as follows. We first define and illustrate the sample and indicate some preliminary features of SEA guidelines selected, with respect to implementation level, length of the document, and application of copyright policies. In the second subsection, we report on the classification of the sample.

4.1 DEFINING THE SAMPLE

We selected a number of SEA guidelines in the period between September to December 2013. We have investigated and retrieved SEA guidance documents at the international level, by using Google search engine and keywords in different languages: "linee guida valutazione ambientale strategica [+ Country's name]", "strategic environmental assessment guideline [+ Country's name]", "strategic environmental assessment guidance [+ Country's name]", "guía de evaluación ambiental estratégica [+ Country's name]", or other similar combinations.

After a first screening, we have identified 22 guidelines that concerns general SEA issues. We used a selection filter which included documents obeying four criteria: i) issued by a EU member state; ii) accessible on-line for free; iii) written up in English or Italian; iv) approved after the publication of (and coherent to) the SEA Directive. The seven documents meeting these filters have been released by the following countries: Ireland (2004), Italy (Formez 2006), Latvia (2007), Portugal (2012), Scotland (2013), Sweden (2010), and the UK (2005). Some countries, such as Italy and Portugal, have inserted SEA Directive principles in the national juridical system well after the expected deadline (June 2004). Fig. 1 shows the localization of the countries, whose SEA guidelines were included in the first screening (in light grey) and finally selected (in dark grey). The guidance documents selected are described in Tab. 2.

Fig. 1 Localization of the countries issuing SEA guidelines included in the first screening (part A) and finally selected (part B)

In most cases, SEA guidelines attain different hierarchical levels, but mostly regard the preparation of plans and programmes. Portugal's SEA guidelines take into account the policy level. Sweden and the UK have longer (with more pages) guidelines with respect to the other states. Three guidelines (Italy, Latvia, and Portugal) do not report information about copyrights (see Tab. 3).
In the next section, we present the first results of a comparative analysis of the documents selected.

EU STATE	DESCRIPTION	PUBLICATION YEAR	NATIONAL SEA REGULATION	ADOPTION YEAR
Ireland	Implementation of SEA Directive (2001/42/EC): Assessment of the Effects of Certain Plans and Programmes on the Environment Guidelines for Regional Authorities and Planning Authorities	2004	Regulations 2004 (Statutory Instrument Number 435 of 2004), and Planning and Development (Strategic Environmental Assessment) Regulations 2004 (Statutory Instrument Number 436 of 2004)	2004
Italy	La Valutazione Ambientale Strategica dei Piani urbanistici e territoriali [Strategic Environmental Assessment of Urban and Regional Plans]	2006	Environmental Code	2006
Latvia	Guidance to SEA in practice	2007	Environmental Impact Assessment (EIA) Act on 26 February 2004 and 15 September 2005 and by new secondary legislation	2004
Portugal	Strategic Environmental Assessment Better Practice Guide – methodological guidance for strategic thinking in SEA	2012	Decree-Law 232/2007	2007
Scotland	Strategic Environmental Assessment Guidance	2013	Environmental Assessment (Scotland) Act	2005
Sweden	Practical guidelines on strategic environmental assessment of plans and programmes	2010	Environmental Code	2004
UK	A Practical Guide to the Strategic Environmental Assessment Directive	2005	Environmental Assessment of Plans and Programmes Regulations	2004

Tab. 2 SEA guidelines in the juridical context (after Fischer 2007)

EU STATE	LEVEL	LENGTH (N. PAGES)	COPYRIGHT
Ireland	Plans	97	yes
Italy	Plans	36	no
Latvia	Plans and programmes	68	no
Portugal	Policies, plans and programmes	76	no
Scotland	Plans	51	yes
Sweden	Plans and programmes	142	yes
UK	Plans and programmes	110	yes

Tab. 3 SEA guidelines: level, length and copyright

4.2 RESULTS

The review of SEA guidelines with respect to the general criteria presented in Tab. 1 is now presented in Tab. 4.

Only the Italian SEA guidelines have been designed for a specific sector, i.e. land-use and town planning. In addition, SEA guidelines published by the UK refer to further guidance documents (partly not available on-line) relating, for example, to transport land use and spatial plans (UK, 2005).

EU STATE	A – SPECIFIC GUIDELINES	B_1 – REGULARLY UPDATED	B_2 – CASE STUDIES INCLUDED	B_3 – AVAILABILITY ON-LINE
Ireland	x	x	x	v
Italy	v	x	v	v
Latvia	x	x	v	v
Portugal	x	x	v	v
Scotland	x	x	x	v
Sweden	x	x	x	v
UK	x	x	v	v

Tab. 4 Classification of SEA guidelines. Key: v for applicable, x for not applicable

The other SEA guidelines are generic, as they have not been prepared for a specific sector. SEA guidelines are not updated regularly in all cases and the oldest ones date back to ten years ago. Only four SEA guidelines refer explicitly to real case studies, even though their description is not complete; Irish SEA guidelines report references to SEA-type assessment cases. Finally, all guidelines are available on-line in PDF format. Since some guidelines have not been updated for several years, some hyperlinks lead to off-line Web resources.

5 DISCUSSIONS

In this section, we discuss the results obtained in the previous section. Italy has recently incorporated the principles of the European Directive in its legislative system. This has caused some delay in SEA implementation within spatial planning systems, both at provincial and municipal level (De Montis 2013; De Montis *et al.* 2013). Public bodies at the provincial and municipal level have prepared SEAs without certain regulations. Sometimes Italian Regions, such as Emilia-Romagna and Lombardy, have adopted specific local regulations inspired to the Directive (De Montis 2013).

Both the UK and Swedish guidelines are quite long (bearing more than 100 pages). However, we do not measure the quality of guidelines by length as long documents may get little consideration. Attention should be paid to this aspect of SEA guidelines; in addition, a good idea to drawn up SEA guidelines is to consider pre-existing material, paying attention to possible copyright issues (Schijf 2011, 491, 494). In our case study, three guidelines do not explicitly refer to copyright.

In general, SEA guidelines are intended to cover various hierarchical levels (from plans to programs) or sectors (land-use, mobility, and so on). Italian guidelines are specific for spatial planning at the municipal level, but they have the limitation that they are not related to the regulations issued in 2006, 2008, and 2010 about the integration of the SEA Directive in the Italian juridical system.

In general we have observed that Guidelines are not regularly updated. Portugal and Scotland have released SEA guidelines rather recently. Late updating may result in: i) the failure to introduce the contents of new regulations, as in the case of the Italian guidelines, and ii) the plight of links to other resources on-line which now are no longer available. In both the cases, the usefulness and reliability of the guidelines is negatively affected.

SEA guidelines include some case studies in quite a useful way, as they help designers in identifying the most effective solutions. Sometimes real case studies are replaced with theoretical examples that help to select the most adapt actions with respect to a particular stage of the SEA process (see, for example, guidelines of Sweden).

Finally, the publication on the Web of the SEA guidelines is a useful option, since it allows an easy and efficient use of those documents and presents other strengths: direct links to external resources, rapid consultation, easy updating, and SEA guidelines available in PDF format are easily printable, becoming available at any time and place and for any individual.

6 CONCLUSIONS

In this paper we analyze the SEA guidelines designed by some EU member states. We have selected seven SEA guidelines following four criteria: i) issued by a EU State; ii) the last freely accessible on-line; iii) written in English or Italian; and iv) drafted after the publication of the SEA Directive and explicitly referring to it.

The guidelines selected have been analyzed with respect to some classification criteria identified in the SEA literature. No SEA guidelines satisfy all these criteria. In general, we have not found a clear prevalence of a guideline over the others.

This analysis is the starting point of further studies on SEA guidelines aiming at: i) enlarging the sample set of guidelines; ii) reporting on specific spatial planning and land-use SEA guidelines; and iii) calibrating evaluation criteria connected to finer SEA implementation issues.

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IMAGES SOURCES

Fig. 1: Picture created by Antonio Ledda; source of dataset: the World Borders Dataset provided by Bjorn Sandvik (thematicmapping.org). The dataset is available under the Creative Commons Attribution-Share Alike License (CC BY-SA 3.0).

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ENERGY AND ENVIRONMENT IN URBAN REGENERATION

STUDIES FOR A METHOD OF ANALYSIS OF URBAN PERIPHERY

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ABSTRACT

Despite planning of urban regeneration has been theorized from several decades, today activating concrete programs encounters major difficulties. Moreover, the structural nature of economic crisis and the operators tendency to maintaining obsolete models of urban transformation certainly do not help to overcome the stalemate.

The article argues, however, that this framework appears to evolve under the influence of some external factors that bring to the fore the importance of the energy - environmental components in the renewal of the existing city.

This address, focused on the concept of urban environment, seems to identify new principles of economic environmental sustainability of the city that converge towards social models of smart community and urban models of smart city.

The article then describes the research in progress regarding an operative method to define explicit and replicable bases of the urban environment concept to be considered in plans of urban renewal. Main fields of observation and measurement are “urban comfort” and “anthropogenic load (pollution)”. An experimental application of the analysis is developed on the eastern area of Rome. Finally, the paper offers specific lines for the research development.

KEYWORDS

Urban rehabilitation and renewal, Mapping urban environment, Urban Heat Island, Urban comfort

1 INTRODUCTION

Since the mid-80s of the last century, if not earlier (Campos Venuti 1987), planning regulations' focus has been on urban regeneration. In plan contents, settings for widespread programmes improving existing settlements quality, especially in the chaotic urban and metropolitan areas, have found an increasing role. Recently, there have been two converging variations on this theme: the stop of the land's use for new constructions and the redevelopment of brown field sites. In real processes, however, there have been no positive signals on both fronts. Despite the prevailing economic crisis, land use is still growing, so that at the institutional level the ISPRA Institute (i.e. *Istituto Superiore per la Protezione e la Ricerca Ambientale*)[1] has raised the alarm. Even with only a superficial observation, there has also been a strongly unbalanced relationship between the increasing number and size of brown field sites (especially in the suburbs) and the smallness of the upgraded or reuse areas.

The same AUDIS association (i.e. *Associazione Aree Urbane Dismesse*), despite the growing opportunities associated to urban heritage, detects a large difficulty for launching regenerative and wide-ranging programmes, so that exclusively considers and promotes them in a future perspective and with respect to a radical change in approach and application models than in the past[2].

The structural nature of the crisis is in fact recognized by many observers, as well as the obsolescence of traditional of traditional urban transformation models, simply based on the push real estate. Nevertheless, the express opening of new directions and standards for the qualification of existing settlements encounters obstacles and inertia, especially in cultural terms and on the part of the operators.

This frame seems relatively fast-moving.

Some factors, outside the established relations system "government-private actors", are beginning to press a change and to overcome the stagnation in the economy of the city. The push to urban transformation begins to take on the energy and environmental value in the qualification of the existing city, more and more in terms of cultural, ideological, programme and urban policies.

These pressures come from:

- progressive enhancement of citizens sensitivity to the energy and environmental issues; the focus is on preservation of natural resources but also on protection of inhabitants health, that is under threat from the effects of unhealthy patterns of settlement; it is widely recognized as the settlements organization (or disorganization) affects the physical health of citizens in terms of pollution, hostile microclimate conditions (European Environment Agency, 2012)3 and induction of unhealthy behaviour patterns[4];
- radical addresses from the EU environmental policies (for example: The 2020 Climate and Energy Package[5]; Commissione Europea 2011; ECORYS SCS Group 2011), programmes and operational initiatives (for example Covenant of Mayors[6]), increasingly directed to local authorities, communities, users, stakeholders, thus overcoming the actions of Nation States and promoting networks at the European level;
- the emergence (just at the beginning) of a new urban economy, no longer based on real estate and construction, but made up of a wide range of sectors related to the so-called knowledge economy and

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1 http://www.isprambiente.gov.it/it/events/il-consumo-di-suolo-in-italia.
2 http://www.audis.it/index.html?pg=12&sub=38&id=13&y=2013.
3 See in particular Box 2.3 Recent major heatwaves in Europe (p 18).
4 See chapter on "Urbanizzazione ed obesità" in Brown LR, 2002.
5 http://ec.europa.eu/clima/policies/package/.
6 http://www.covenantofmayors.eu/index_en.html.

the green economy; but especially to finding of an economic structure whose actors are different from the traditional ones (builders, property developers and something like that), because are more sensitive to innovation, environmental protection, cultural-scientific processes and changes that are proposed for urban areas (new sectors such as ICT, Renewable Energy Sources, bio-agri-food, advanced logistics, new materials, advanced services, etc.; and new actors of the social economy such as new forms of cooperatives, groups of crowd funding, formal and informal associations of citizens, etc.).

The future outlook seems to address urban regeneration towards new economic and environmental standards of city's sustainability, aimed to cultural growth of population and their inclusion in transformative processes, as well as to defined models smart community. To these, dialectically correspond smart city's settlement patterns (European Parliament 2014), where the energy and environmental component, shared and owned by the settled community, is one of the main development drivers of the model itself. Developing such address, it is important to study and decoding the urban environment concept, as defined by the EU (Commissione delle Comunità Europee 2005), as a result of the settlements impact in terms of damage to the finite natural resources and their effects on ecosystems and on the quality of life, as well as the scope of the community attention. So it is necessary an in-depth study on the impacts that spatial configuration and functional organization of settlements exercise on urban environment.

2 APPLICATION OF RESEARCH TO THE EASTERN QUADRANT OF ROME

To provide a contribution and an improvement to the above study, paper's authors have been experiencing, after a long time, a research on energy and environmental characterization, applied to the vast suburban area to the east of Rome. This research has been experimenting with an analysis and intervention method that combines traditional urban systems analysis with other specific issues, arising from systemic reading of the territory and use of energy, integrated, ecological and environmental parameters with urban ones. In order to build a course of action for urban regeneration, aimed at improving urban environment quality, the environmental value rises additional terms rather than replace the traditional content of the plan. However, it assumes a structural nature, as tends to disturb and to permeate the other parameters that converge in the project.

The choice of an area in the Roman suburbs was driven by the belief that these urban and metropolitan areas currently produce the greatest impacts on the urban environment and they can be a collection of positive outcomes for living communities and for the entire urban area. In particular, the area, deeply populated and overlap of different practices (formal and informal) of urbanization after World War II, is located in the eastern part of Rome (the current IV and V Municipality), and is assumed as more representative sample in terms of specificity (local, natural, agro-forestry, historical and identity resources, etc) as well as critical aspects of the city (high building density and population, pollution from vehicular, settlement and industrial load), and more generally, to the contemporary one.

The goal of the survey methodology is to direct the urban regeneration processes (and the instrumentation of planning) towards the quality (ecological and environmental performance) of the urban environment's improvement. The human activities and, in particular, the urban pollutants factors (transport, heating of buildings, manufacturing activities) – or in other words the same physical and functional organization of the settlements – in fact, alter the physical, chemical, biological and morphological features of the natural environment; lead to dramatic consequences on the natural environment and human health in the first place, and not least on ecosystems and the cultural and historical heritage.

3 THE ENERGY AND ECOLOGICAL CHARACTERIZATIONS OF THE CITY: ELEMENTS FOR THE CONSTRUCTION OF A METHODOLOGICAL FRAMEWORK

The main research goal refers to articulate components in order to define the urban environment's concept in urban regeneration, through explicit and replicable basis.

At this early stage of investigation, we have been considering some factors that characterize urban environment, although they positioned between the main nodes of the contemporary city, are still not scientifically declined in the urban planning:

- residential load, in terms of pollution;
- fossil fuels' energy uses and traditional inefficient systems;
- microclimatic comfort of urban space.

These factors are obviously interrelated in cause-effect relationships and their separate treatment is instrumental, useful mainly in analytical terms, and suitable for the reconstruction phase of the project. This is true in terms of their relationship with physical and functional organization of the urban system, in order to address the plan/process toward combined strategies of adaptation and mitigation, according to the approach used by the European Environment Agency. The ultimate aim is urban sustainability's pursuit, according to the conceptual relativism of the transition (Efficiency in Transition). Defining these factors' features permits a qualitative and quantitative measurement of the observed phenomena through indicators and the resulting graphical representation with the help of indirect variables, because of specific environmental and disaggregated data's lack. The developed experimentation refers to a process plan as a cross between the top-down path (for example the General Plan, i.e. PRG, or the metropolitan one) and the bottom-up one, resulting from participatory procedures and therefore physiologically generated in limited areas. We believe that at the meeting of these two pathways (descending and ascending) it is possible effectively to intercept the above-mentioned environmental factors, as well as the total binder of the content and parts of the master plan. The environment characterizations, as previously established, are particularly evident in the compact urban periphery, as the East Area of Rome, where it is set the experimentation and where it is proposed a hypothesis of comparison and integration of these issues with the addresses of the new General Plan (PRG). The methodological route adopted in the first phase of experimental application follows two main directions of investigation, related to:

- assessment of urban comfort;
- anthropogenic load's determination, in terms of pollution.

In order to evaluate urban comfort, are taken into consideration:

- permeability of the soil, i.e. evapotranspiration's capacity in urban areas, responsible for temperature's mitigation processes. It is evaluated surface coverage of the individual blocks, in order to have the mainly artificial areas and also more permeable ones;
- quantity and quality of the green areas, a parameter closely linked to the previous size and also responsible for the mitigation's processes, as well as the improving of the open spaces' liveability; the analysis focuses on the natural heritage that is examined as the maintenance degree and the green areas' usability;
- *albedo*, as reflected fraction of solar radiation, linked to the colour and nature of the surface materials and the settlement's parts;
- urban heat island – or rise in urban temperature compared to rural surroundings, because the physical and functional features of the settlement – is considered the evidence test of urban metabolism. It represents the result of the above mentioned factors plus other effects (such as thermal trap,

anthropogenic heat, pollution, particulate matter, etc.) and is useful in locating the main urban conditions of discomfort in our latitudes in terms of microclimate; its evaluation is done by parametric simulations (fig. 1).

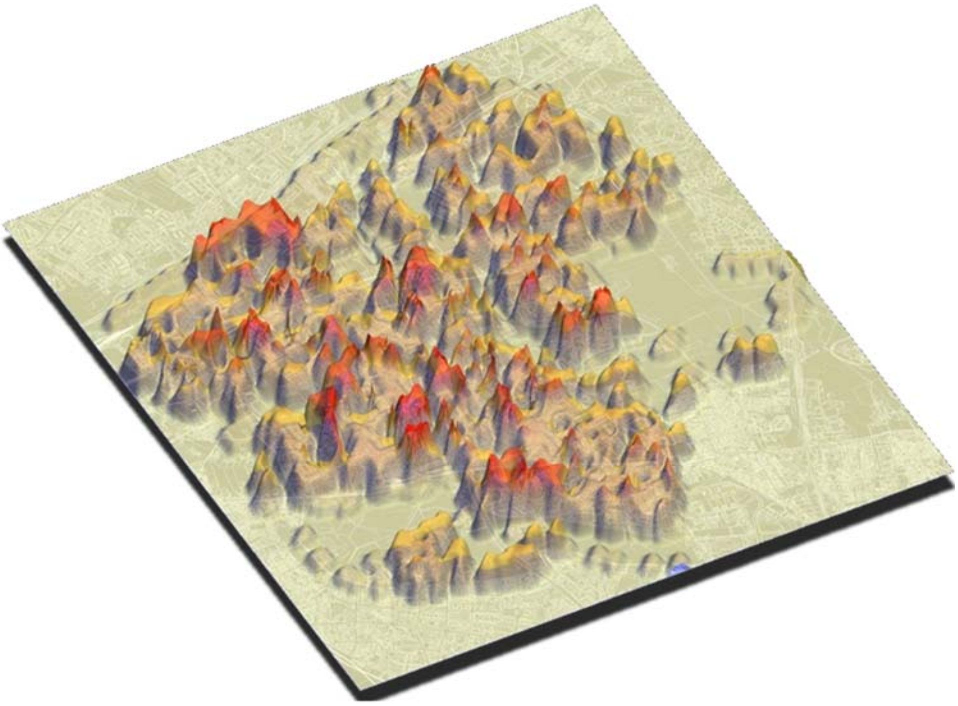

Fig. 1 Representation of heat island for the Eastern quadrant of Rome

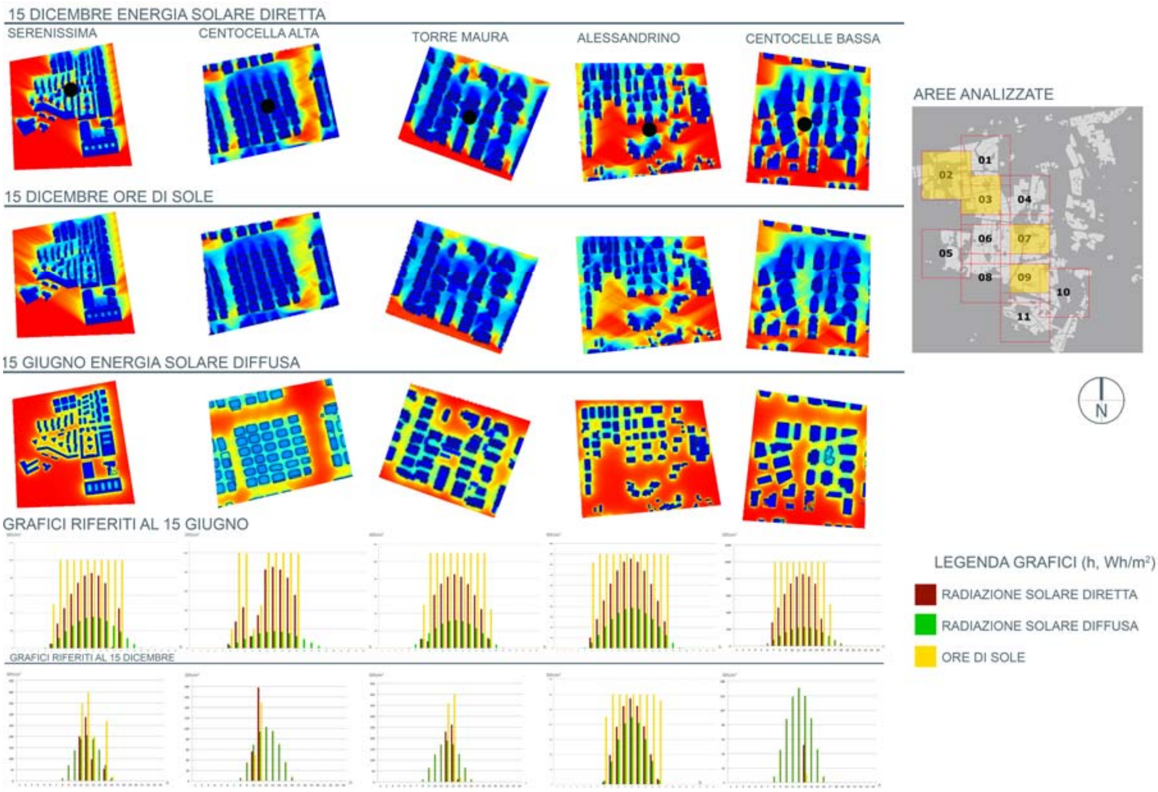

Fig. 2 The urban comfort represented by Townscope 3.2

Deeper analyzes on urban comfort are carried out on a smaller scale using specific simulation software and then different part are reassembled. The software is able to connect urban form to urban microclimate conditions through some specific factors (sky view, solar accessibility, orientation and wind protection) (Fig. 2). These assessments can be carried out ex ante and ex post, to validate the plan indications. To assess anthropogenic load that persists in the chosen urban sector, we evaluated the main components responsible for energy consumption and corresponding emissions in the three major functional areas: residential, vehicular and industrial load. The outlined analysis certainly simplifies the various interrelationships between different urban contexts (an impact does not end just inside the block and / or in close proximity to roads), as well as the various sectors involved (the interaction between the various loads, in fact, it is often more important than the sum of individual ones).

For the residential load is used an indirect indicator, such as the population density, that proceeds up to the block's level for more dense areas and census section's terms (census section) for more sparse ones. The density calculated in this way identifies "full" residential areas, in terms of crowding index, but especially of energy demand - with a certain degree of approximation, acceptable to large scale and certainly more detailed than other studies carried out by specialized institutions (for example by ENEA, De Pascali, *et al.* 2012, 97) and then in the most general sense of pollution. For the vehicular load, we have analyzed the values from a flow diagram (*Flussogramma del traffico,* realized by the municipal public transport - ATAC) that through a road graph represents equivalent vehicles/hour, actually transiting on the road, not just locally. Depending on these values and interfacing them with the most critical nodes of the roads (seen directly through targeted inspections at different times of the day) we have determined the most affected infrastructure networks by noise, combustion and particulate pollution.

Finally, for productive activities have been identified "charge" areas through a cross-examination between the pollution's level of the various activities with the number of employees (size of the business), according to the census section, inductively aggregating in families impacts (low, medium and high intensity). This process does not consider any abandoned production activities linked to the recent crisis, but more importantly, for technical and procedural needs, "spreads" over the census section the entire productive load, because it would be too complex succeed in locating every single industrial plant. Also in this case the approximation's area is acceptable for large-scale evaluations.

Once you have defined these parameters, we were able to determine critical areas (i.e. the contexts with the most significant levels of discomfort and pollution), on which is a priority action.

Referring to the ordinary urban analysis and interfaced them with the processing outlined above, the survey methodology involves a synthesis map, for the territorial synthetic evaluation, in terms of the critical and value elements.

In particular, overlapping polluting elements to the environment system (in terms of its ecological and landscape quality, variety and state of repair of uses, ...), to the settlement one (with an emphasis on the completeness or not of the functional and morphology structure in the residential blocks) and the relational one (Fig. 3).

It is possible to notice how there are urban settings with a particular population's density and at the same time a significant concentration of pollutants from transport (for equivalent vehicles/hour and critical infrastructure nodes). But not only. There are also more or less informal and/or semi-structured parts of blocks, marginal to the man-made environment and next to productive activities, relevant to the type of pollutant, number of employees, as well as the overall size (large areas waterproofed used for the loading and unloading of goods) and accessibility. Substantially the critical areas are defined relatively to the whole area and not in absolute terms, as results of overlapping quantitative parameters (maximum values of pollution and discomfort) and qualitative evaluations (green quality). The limits of the areas, although indicative, are useful to identify the origin of the observed phenomena on which to intervene, and to take into account their variability. The achieved approximation is still consistent with the urban plan scale, according to the discipline statute (Mazza 1997) describes urban planning as approximate research). Contributing to this the imprecision of the tools and available data. Further analysis is performed at lower scale with appropriate simulation tools.

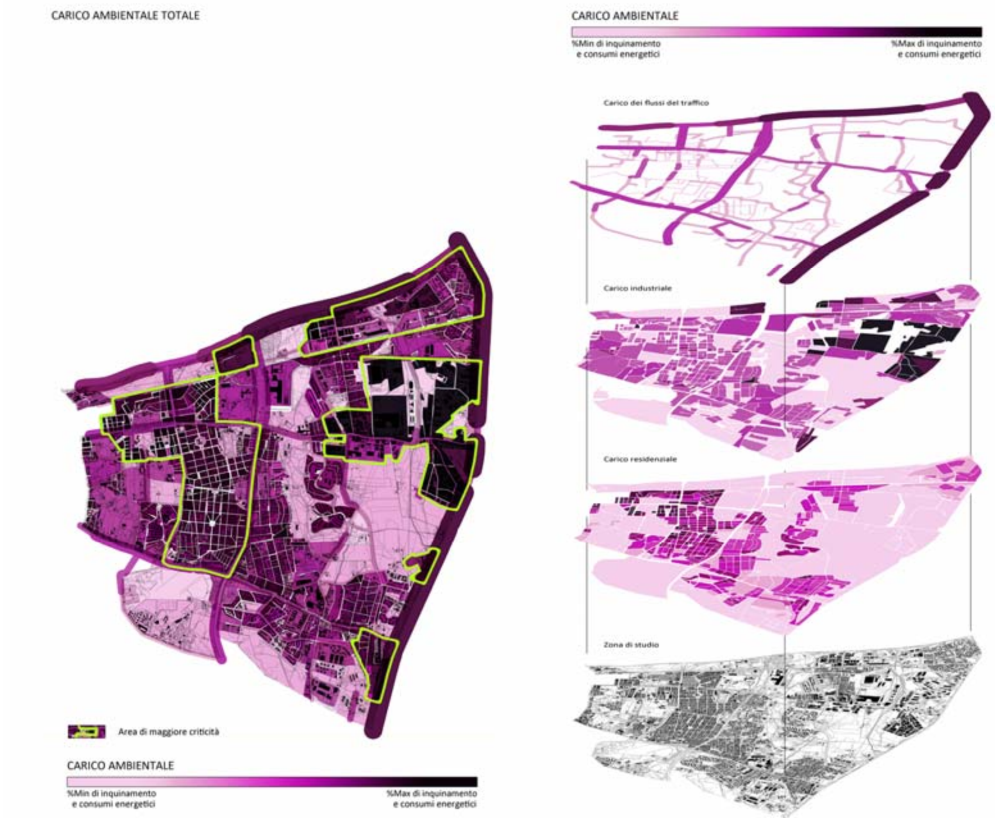

Fig. 3 – Representation of the anthropogenic load

Subsequently, and in parallel to collecting of ad hoc references, it is outlined an energy and environmental value process, in terms of

- entire urban sector (general layout of the study area with the preparation of a master plan according to three thematic analysis' levels - ecological and environment system, settlement system and relational one - interconnected each other in order to outline a holistic and systemic urban regeneration);
- thematic analysis (i.e. detail and critical evaluation and possible resolutions relating to the operational scales of reference that are considered more significant), in order to identify by priorities actions, able to exploit in the analyzed context the valuable elements and minimize the critical ones, identified in the previous phase synthesis.

A specific line of research also concerns the use of innovative graphic representations about the territorial aspect of the phenomena, with the aim of producing representative and evocative images, as well as useful to activate any participatory processes.

4 CONCLUSIONS

From the advance of research, and in particular from the comparison of methodological hypotheses with real situations, emerge different lines of development for the future. At least two of these need an in-depth knowledge to proceed in the methodological and operational research.

- Urban environment analysis collides with the detailed and disaggregated data's lack, especially in urban settlements areas, where you do not realistically make direct campaigns and field survey. That raises a need of simulation codes, on at least some important parameters (for example energy consumption and related emissions, not only connected to residential activities but also transport and production ones). Such simulators have to be both reliable (the level of approximation is within the degree of acceptability for an urban plan) and expeditious (easily usable with available data and also replicable in every situation). In this context, it is necessary an applied research, possibly in cooperation with other specific groups and experts, for simplifying prototype's development, adapting to our urban situations and producing quality cartographic tools, usable also in participatory processes. So it is necessary going deeper into the state of the art, about the pervasive and embedded systems (such as sensor), low cost and easy to use technologies, for direct and continuous measurements.
- The current deep economic crisis does not help in creating the conditions for an urban regeneration's start. The thrust of the housing market appears to have structurally weakened; it appears necessary, and in some ways can't be postponed, to follow other engines for urban regeneration, more closely to the contemporary city. In this sense, the eco-energy sector seems to have the potential to become, also because its significant and economic potentialities, its congruence with the stringent EU policies and because of opportunities in social involvement and inclusion.

It is however necessary recover the non-research and development in the field, mainly caused during a long period when the central energy system has locked up the local initiative. In this sense, it seems extremely important studying the settlement patterns' integration, based on widespread eco-energy systems, with participatory and inclusive social models, starting from the analysis of best practices and experiences, developed in other European countries.

The objective of the paper and the outlined search path is to contribute to broadening the debate and collaboration on the study of the environmental parameter in urban planning. It seems evident that the physiological evolution of what was called "democratic planning" cannot fail to pursue the quality of the urban environment as it is produced by the organization of settlements, in integration and synergy with the statutory originate contents.

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Figg. 1, 2, 3, 4: Students works from Course of urban recovery and requalification, resp. Prof. Paolo De Pascali, Sapienza, University of Rome.

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