TeMA

Journal of
Land Use, Mobility and Environment

There are a number of different future-city visions being developed around the world at the moment: one of them is Smart Cities: ICT and big data availability may contribute to better understand and plan the city, improving efficiency, equity and quality of life. But these visions of utopia need an urgent reality check: this is one of the future challenges that Smart Cities have to face.

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).

CITIES, ENERGY AND CLIMATE CHANGE

Vol.8 n.1 April 2015

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA

Journal of
Land Use, Mobility and Environment

CITIES, ENERGY AND CLIMATE CHANGE

1 (2015)

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realised by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

Cover image: digital processing Raffaella Niglio, image Paolo De Stefano

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

The Italian *National Agency for the Evaluation of Universities and Research Institutes* (ANVUR) classified TeMA as scientific journal in the Area 08. TeMA has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA
Journal of
Land Use, Mobility and Environment

CITIES, ENERGY AND CLIMATE CHANGE 1 (2015)

Contents

TeMA Journal of
Land Use, Mobility and Environment

EDITORIAL PREFACE:

CITIES, ENERGY AND CLIMATE CHANGE

ROCCO PAPA
DICEA - Dipartimento di Ingegneria Civile, Edile ed Ambientale
University of Naples Federico II
e-mail: rpapa@unina.it
URL: www.roccopapa.it

Urban population is rapidly reaching two thirds of the global population; thus, cities are the core of a change that need to be driven: the rapid urban population growth involve a large energy consumption and high greenhouses gas emissions which drive cities to face environmental challenges like as climate changes and energy resources' scarcity. As remarked by the last Report of the United Nations on Sustainable Development, climate change is one of the greatest challenges of our time and adequate strategies capable of mitigating and adapting to its impacts represents an immediate and urgent global priority. This issue of the TeMA focuses on the topic of Cities, Energy and Climate Change, focusing on current strategies addressed to mitigation and adaptation.
The first article of this issue, titled "The Padanian LiMeS. Spatial Interpretation of Local GHG Emission Data" by Michèle Pezzagno and Marco Rosini focuses on the relevant role of spatial planning in the enforcement of climate change mitigation that could have a part in managing the development of new low-carbon infrastructures and increasing system-wide efficiencies across sectors, has been addressed at global level (IPCC, 2014 WGIII). The paper then stress on the role of local GHG inventories as a tool towards the definition of a coherent, inter-sectorial background for local planning, mitigation, and adaptation policies. Taking advantage of consistent GHG emissions data availability in the Lombard context, the article links local maps of direct GHG emissions with geographic data, including municipal boundaries, population data, and land-use information, produced and organized within the research PRIN 2007 "From metropolitan city to metropolitan corridor: the case of the Po Valley Corridor". The results of this mapping exercise have been evaluated on the background of consolidated knowledge about northern Italy urban patterns, including the Linear Metropolitan System – LiMeS – and preliminary observations about characteristics, potential, and limits of the tool are proposed.
The second article titled "Smart and Resilient Cities. A Systemic Approach for Developing Cross-sectorial Strategies in the Face of Climate Change" by Rocco Papa, Adriana Galderisi, Maria Cristina Vigo Majello and Erika Saretta focuses on the Smart City and Resilient City concepts. The article, based on the review of existing literature, analyses the synergies between the two concepts, highlighting how the Smart City concept is more and more widely interpreted as a process addressed to make cities "more liveable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Nevertheless, current initiatives to improve cities' smartness and resilience in the European cities are very fragmented and

operational tools capable to support multi-objective strategies are still at an early stage. To fill this gap, embracing a systemic perspective, the paper identifies and arranges into a conceptual model, main characteristics of a smart and resilient urban system. The latter represents a preliminary step for the development of an operational tool capable to guide planners and decision-makers in carrying out multi-objective strategies addressed to enhance the response capacities of complex urban systems in the face of climate change.

The third article by Thomas Hartmann and Tejo Spit titled, "Implementing European climate adaptation policy. How local policymakers react to European policy", uses two Dutch cities as an empirical base to evaluate the influence of two EU climate adaptation projects on both the experience of local public officials and the adaptive capacity in the respective cities. The main conclusion is that EU climate adaptation projects do not automatically lead to an increased adaptive capacity in the cities involved. This is due to the political opportunistic use of EU funding, which hampers the implementation of climate adaptation policies. Furthermore, these EU projects draw attention away from local network building focused on the development and implementation of climate adaptation policies. These factors have a negative cumulative impact on the performance of these transnational policy networks at the adaptive capacity level in the cities involved. Therefore, in order to strengthen the adaptive capacity in today's European cities, a context-specific, integrative approach in urban planning is needed at all spatial levels. Hence, policy entrepreneurs should aim to create linkage between the issues in the transnational city network and the concerns in local politics and local networks.

The section Land-use, Mobility and Environment collect two articles. The first one titled Interactivity of Web GIS for the Simulation of Land Development by Tullia Valeria Di Giacomo focuses on the spatial data knowledge and the development of new ICT solutions, which can guide the planner towards strategic, reliable and shared decisions. The paper proposes a methodology useful to specialize the special approach established in previous projects developed by extending and implementing GIS technology Geographic Information System towards online interoperability. The control of the effects of changes in land use in environmental quality, particularly in the water resources management, can thus become operational in the network through the application of innovative tools able to meet the new challenges of urban regeneration.t

In the same section, the article titled "Cycle sustainability" by Francesca Pirlone and, Selena Candia shows the sustainability of cycling according to socio-economic (social and economic sustainability) and environmental terms (environmental sustainability), thought a CBA (Cost and Benefits Analysis) methodology specific to evidence the advantages of investments in cycling made by public authorities or private companies both, to promote and realize ecological infrastructures.

Finally, the Review Pages define the general framework of the theme of Smart City Environmental Challenges with an updated focus of websites, publications, laws, urban practices and news and events on this subject.

REFERENCES

Kunzmann, K.R (2014). Smart Cities: A New Paradigm of Urban Development. Crios, 1/2014, pp. 9-20, doi: 10.7373/77140.

TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2015) 5-18
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2877

review paper received 12 January 2015, accepted 23 April 2015

www.tema.unina.it

How to cite item in APA format:
Pezzagno, M. & Rosini, M. (2015). The Padanian LiMeS. Spatial interpretation of local GHG emission data. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 5-18. doi: http://dx.doi.org/10.6092/1970-9870/2877

THE PADANIAN LIMES

SPATIAL INTERPRETATION OF LOCAL GHG EMISSION DATA

MICHÈLE PEZZAGNO [a], MARCO ROSINI [b]

Department of Civil Engineering, Architecture, Territory, Environment and Mathematics (DICATAM), University of Brescia
[a] e-mail: michele.pezzagno@unibs.it, [b] marco.rosini@unibs.it

ABSTRACT

The relevant role of spatial planning in the enforcement of climate change mitigation, managing the development of new low-carbon infrastructures and increasing system-wide efficiencies across sectors, has been addressed at global level (IPCC, 2014 WGIII). In this context, local GHG inventories appear a relevant tool toward the definition of a coherent, inter-sectorial background for local planning, mitigation, and adaptation policies.
Taking advantage of consistent GHG emissions data availability in the Lombard context, local maps of direct GHG emissions have been linked with geographic data – produced and organized within the research PRIN 2007 *From metropolitan city to metropolitan corridor: the case of the Po Valley Corridor* – including municipal boundaries, population data, and land-use information.
The results of this mapping exercise have been evaluated on the background of consolidated knowledge about northern Italy urban patterns, including the Linear Metropolitan System – LiMeS – and preliminary observations about characteristics, potential, and limits of the tool are proposed.

KEYWORDS:
local carbon emissions inventories, GHG accounting, climate change mitigation.

TeMA 有关土地使用、交通和环境的杂志

TeMA 1 (2015) 5-18
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2877

review paper received 12 January 2015, accepted 23 April 2015

www.tema.unina.it

How to cite item in APA format:
Pezzagno, M. & Rosini, M. (2015). The Padanian LiMeS. Spatial interpretation of local GHG emission data. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 5-18. doi: http://dx.doi.org/10.6092/1970-9870/2877

帕达尼亚 LIMES

对当地温室气体排放数据的空间解读

摘要

空间规划在执行气候变化缓解政策、管理新低碳础设施的发展以及提高全系统效率中的相关作用已获得了全球层面的阐述（IPCC, 2014 WGIII). 在这个背景下，当地温室气体清单变成为当地的规划，缓解和适应政策确定连贯，跨部门背景的相关工具. 通过利用伦巴第环境中统一温室气体排放数据的可用性，直接温室气体排放的本地示意图已与名为 从大都市到都市走廊:波河流域走廊案例分析 的 PRIN 2007 研究所产生和整理的地理数据相联系，其中包括城市边界，人口数据和土地利用信息. 本次图上演示的结果已在意大利南部城市形态的巩固知识的背景下进行了评，其中包括线性都市系统“LiMeS”，并提出了对这个工具的特征,潜力和限制的初步观察.

MICHÈLE PEZZAGNO [a], MARCO ROSINI [b]

Department of Civil Engineering, Architecture, Territory, Environment and Mathematics (DICATAM),University of Brescia
[a] e-mail: michele.pezzagno@unibs.it, [b] marco.rosini@unibs.it

关键词
当地碳排放清单，温室气体核算，气候变化缓解

1 INTRODUCTION

The present effort in climate modelling, including global greenhouse gases (GHG) monitoring and accounting, is unprecedented in human history. The establishment of a global carbon budget, aimed at keeping the increase of global temperature within 2-Celsius degrees above pre-industrial levels, has deep economical, social and political implications. Therefore, carbon accounting methodologies are catalysing a growing attention from the most diverse disciplinary sectors.

The atmospheric carbon balance is only one of the key components of the global dynamic equilibrium: biodiversity, stratospheric ozone, nitrogen and phosphorous cycles represent other domains in which human action must be contained within global limits. However, what makes the concentration of GHG peculiar among global limiting factors is its pervasive influence on almost all natural and anthropogenic systems.

Rising the concentration of carbon dioxide and other greenhouse gases in the atmosphere we do not only increase the global temperature and its burden of perilous consequences, but we are notably reducing the dispersion of *entropy* toward the cold sink of outer space through thermal infrared irradiation, thus affecting the efficiency of almost every process occurring within the biosphere. Furthermore, anthropogenic climate change stands apart from all the environmental issues we have faced so far because we are challenging a global, pervasive limit that involves significant changes in all aspects of human activity, at least as long as our energy system is mainly supported by the use of fossil fuels.

The analysis and interpretation of GHG emissions values poses unique challenges since emissions are produced by a very large number of processes and the hyper-connected structure of our economy, as well as the role of technological evolution, should always be carefully considered.

At urban scale the multi-dimensional nature of the energy issue, which is deeply connected with carbon emissions, has been underlined and the limits of sectorial approaches have been described, in contrast with the need of quantitative, holistic studies (Papa, Gargiulo, Zucaro, 2014b). In this perspective, local carbon emissions inventories can represent a pertinent analytical instrument. However, cities and regions are open systems and, since the relative weight of the energy and material flows exchanged by local systems through their boundaries tends to increase as the scale of the system decreases, preparation and interpretation of local inventories pose several challenges that have to be properly addressed (Pezzagno, Rosini, 2014).

Under these premises, the present contribution is mainly aimed at summarizing the methodologies adopted for developing carbon inventories at local scale and at revising the main approaches adopted for addressing the 'responsibility problem'. A mapping exercise on the LiMeS urban system in Northern Italy, based on existing GHG emissions datasets, is then presented in order to discuss the relevance, the possible applications, and the limits of the tool.

Recent experiences have shown how the preparation and certification of local GHG inventories, together with the co-operation between academic, legislative and administrative organizations, are important points for a sustainable management of an administrative jurisdiction, providing positive environmental effects (Bastianoni, Marchi, Caro, Casprini, Pulselli, 2014).

In this context, the spatial mapping of coherent time series of carbon emissions data, including the analysis of sectorial emissions in relationship with land-use classes, can provide further insights and could be positively adopted as a significant reference for spatial planning and local decision-making.

2 CARBON ACCOUNTING AT LOCAL SCALE: GENERAL REMARKS

Anthropogenic greenhouse gases represent a peculiar category of pollutants: they affect the global ecosystem independently from their point of emission[1], while their direct effect on local ecosystems can often be considered negligible, like in the case of carbon dioxide. Furthermore, their generation is commonly

[1] This is not true for some categories of climate-influencing pollutants like black carbon (IPCC, 2014a).

connected with the production of electric power or goods that can be exported and consumed far away from the site of production. A local reduction of emissions – achieved, for example, by relocating an industrial facility in another region – can paradoxically represent an *increase* in global emissions, determined by the added relocation and transport costs (i.e. the emissions generated for building the new infrastructure and transporting the goods back to the original market).

For this reason, the theme of GHG emissions *responsibility* in open economies represents a complex and relevant topic that has been already discussed since in the earlier stages of development of carbon accounting methodologies (Munksgaard, Pedersen, 2001), when it soon became clear that the problem of properly assigning the liability for carbon emissions represents a primary issue at sub-national and local scales (Bastianoni, Pulselli, Tiezzi, 2004).

Producers and consumers, importers and exporters can be always considered co-responsible, and two main approaches have been proposed in order to solve the liability dilemma: the geographical (or producer-responsibility) and the consumer-responsibility approach, which will be summarized and commented in the next paragraph. Another major difficulty, when dealing with local inventories of greenhouse gases, is then represented by the fact that the relationship between the reduction of emissions and the overall performance, the health, and the resilience of local systems is not necessarily linear. With regard to the significance of local carbon emissions inventories at local scale for spatial planning, it is worth noting that GHG emissions can be, in the first place, considered as an *entropy-proxy*: a general representation of local processes energy-intensity. In this perspective, local carbon emission inventories can be used as a tool to discuss the efficiency and the evolutionary trajectories of cities and local systems with reference to their production of entropy, in the perspective proposed by Fistola and La Rocca (2014).

Furthermore, GHG emissions are strongly related with the dense idea of urban *resilience*.

The complex concept of resilience has been proposed as logic and semantic pivot for addressing climate change at local and urban level (Galderisi, Ferrara, 2012), including both mitigation and adaptation strategies. Indeed, although a differentiation between mitigation measures, aimed at reducing GHG emissions, and adaptation measures, aimed at adjusting natural or human systems in response to actual or expected climatic stimuli or their effects is widely adopted, it is worth noting that these concepts are deeply interconnected and should never be considered as independent. This observation is only apparently basic, and has relevant consequences when considering the role of spatial planning at regional and local scale for tackling anthropogenic climate change and its consequences.

While the importance of spatial planning is evident when dealing with *adaptation* policies for enhancing the resilience of infrastructures, ecosystems, and economies (IPCC, 2014, WGII), the role of urban and regional planning has been clearly addressed as pivotal[2] in the enforcement of Climate Change Mitigation (i.e. reduction of local GHG emissions, development of low-carbon infrastructures) only recently.

The relevance of cities as *loci* of energy consumption and GHG emission has been clearly underlined, since urban areas account for between 71 % and 76 % of CO2 emissions from global final energy use (IPCC, 2014, WGIII), but satisfactory models and practices for tackling mitigation at urban level still appear in their early stages of development (Papa, Gargiulo, Zucaro, 2014a).

This is hardly surprising: it's difficult to separate, to clearly distinguish the city from the evolving background of the entire human activity. In particular, as we recognize the fundamental importance of technological evolution (in power generation, industrial processes, transport, etc.), it appears quite natural to expect that cities could just follow the stream of technological innovation, progressively adopting better solutions as in the case of mitigation policies based on buildings energy-efficiency.

2 As pointed out in IPCC AR5 - WGIII, Chapter 12, the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007) did not have a chapter on human settlements or urban areas. Urban areas were addressed through the lens of individual sector chapters. Since the publication of AR4, there has been a growing recognition of the significant contribution of urban areas to GHG emissions, their potential role in mitigating them, and a multi-fold increase in the corresponding scientific literature.

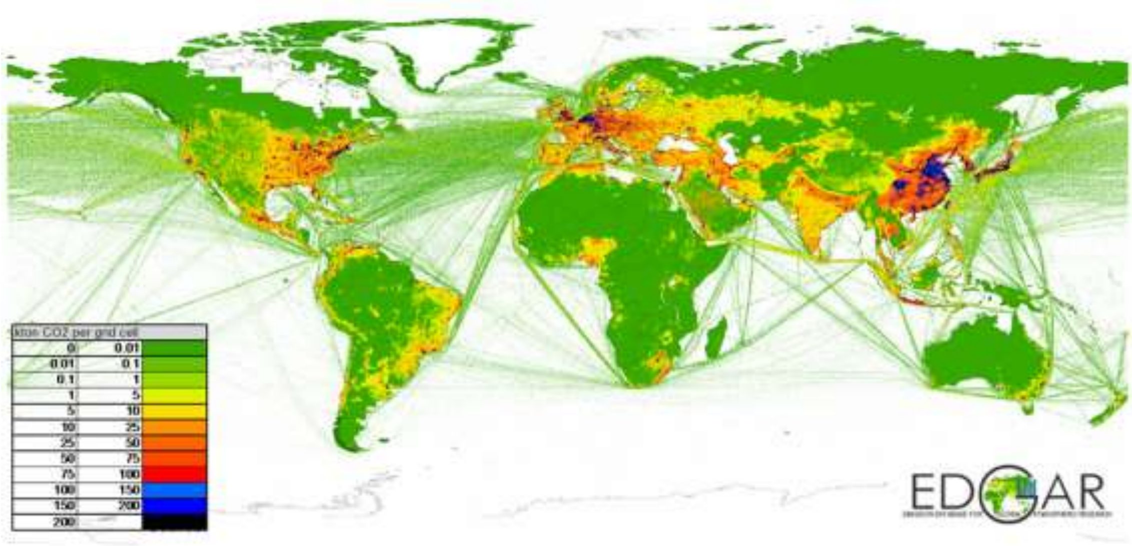


Fig. 1 Global gridded carbon dioxide emissions from fossil fuel and other anthropogenic direct emissions (excluding aviation and organic carbon emissions) expressed in kton of CO2 per 0.1x0.1 deg cell (2005 values). EDGAR inventory 4.0.

This assumption can appear fairly reasonable, but it is radically insufficient if we consider the countless opportunities of systemic, cross-sectorial efficiencies, industrial symbioses, and smart urban settings that can be properly addressed only through an appropriate spatial analysis and with effective planning tools.

3 GEOGRAPHIC AND CONSUMER-RESPONSIBILITY CRITERIA IN CARBON EMISSIONS ACCOUNTING

The Kyoto Protocol, adopted in December 1997 and finally entered into force in 2005, has established emission reduction objectives for Annex B[3] Parties, which are committed to develop, publish and regularly update national emission inventories of greenhouse gases as well as formulate and implement programmes to reduce these emissions.

In order to establish compliance with national and international commitments, national GHG emission inventories are compiled according to the guidelines provided by the United Nations Framework Convention on Climate Change (IPCC, 2006). Emission estimates comprise six direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), which contribute directly to climate change due to their positive radiative forcing effect, and four indirect greenhouse gases (NOx, CO, non-methane volatile organic compounds, and SO_2).

The IPCC guidelines for GHG accounting, developed from a revision of a precedent 1996 version, have been designed in order to ensure the transparency, consistency, comparability, accuracy and completeness of the inventory provided by the national authorities, and consider 4 emission sectors: (1) Energy, (2) Industrial Processes and Product Use, (3) Waste, and (4) Agriculture, Forestry and Other Land Use (AFOLU). It's worth noting that national inventories are updated annually in order to reflect revisions and improvements in the methodology and adjustments are applied retrospectively to earlier years, which accounts for any difference in previously published data.

The IPCC methodology adopts a polluter-responsibility approach, also indicated as territorial or *geographic approach*, since countries are held responsible for all GHG emitted from their domestic territory.

3 Annex B parties are industrialized countries and countries with economy in transition (Annex I Parties) with first- or second-round Kyoto greenhouse gas emissions targets.

The main problem determined by the adoption of a geographical approach as a reference for emissions reduction policies in a limited number of countries is represented by the risk of inducing *carbon-leaking* phenomena, i.e. the re-localization of energy intensive industries and technologies from nations with strict climate policies. Furthermore, adopting the geographic principle, a territory can be considered 'virtuous' even if imports energy and carbon-intensive goods, because it does not *directly* emit greenhouse gases.

The problem of *indirect emissions* is considered by other organization-based GHG accounting systems, like proposed in the EU LIFE LAKS project, or in the recently launched[4] GHG protocol for Cities (ICLEI, 2012), including the *consumer responsibility* (or just responsibility) *principle*.

In these frameworks the accounting of direct emissions, namely the emissions rising from within the city boundaries (see fig. 2, Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, Scope 1), is followed by the accounting of indirect emissions generated for producing the imported energy (grid supplied power, Scope 2) and other indirect emissions (wastes, power transmission and distribution, out of boundary transportation, Scope 3).

The main advantage of adopting a geographical approach within a local context is represented by the consistency and coherence of results between different territories and different scales. A province or a municipality can be considered as a subsystem of the national inventory, its inventory can be compiled following the same methodologies, and consistently updated over the same time series.

Actually, the IPCC guidelines include the possibility of adopting bottom-up approaches for the compilation of higher-precision esteems. Local inventories can thus represent a contribution to national accounting efforts, just like national inventories compose the global esteem that can, and must, be verified in atmospheric concentrations.

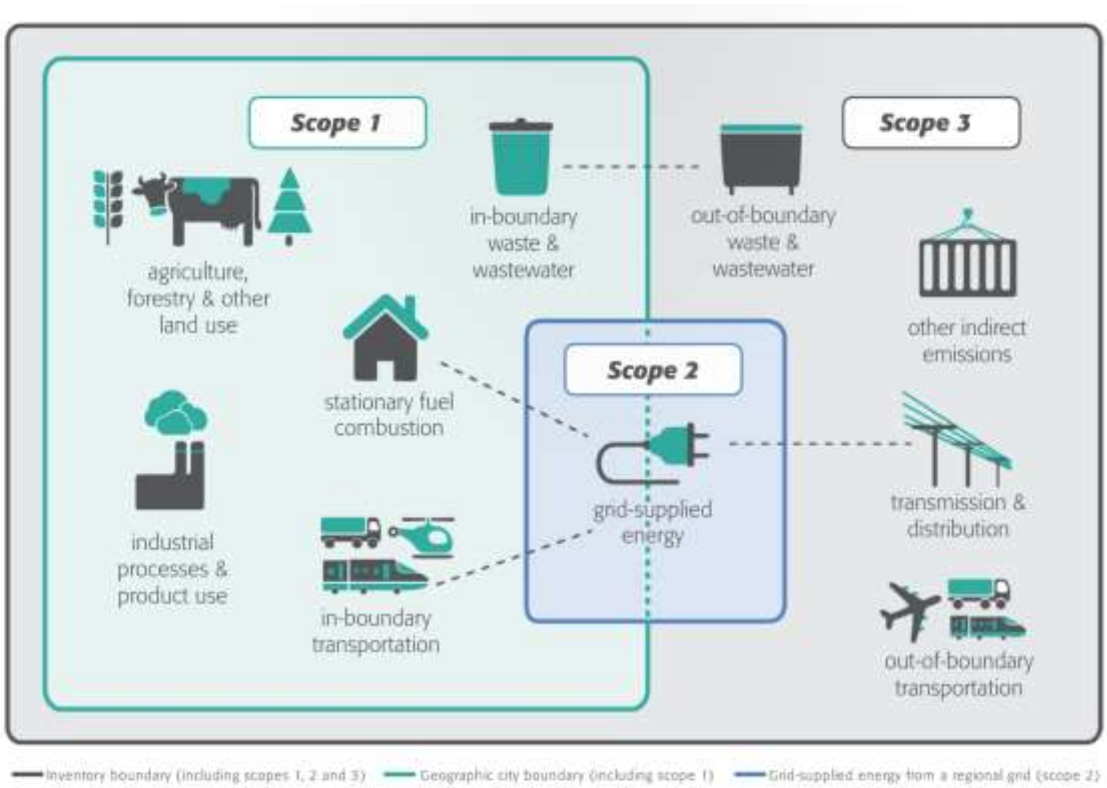


Fig. 2 Following the "responsibility principle": sources and boundaries of city GHG emissions in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).

4 The GPC has been adopted, among other initiatives, by the Compact of Majors and has been launched on December, 8 - 2014 in Lima by the lead authors World Resources Institute, C40 Cities Climate Leadership Group, and ICLEI - Local Governments for Sustainability.

Direct measurements and remote sensing techniques can be used for comparison with direct emissions inventories, like in the case of the Megacities Carbon Project (Duren, Miller, 2012), or the CO2 MegaParis Project (Bréon, et al, 2015).
On the other side, the main advantage of adopting approaches developed including the 'responsibility principle' is that the results give a more complete, sound picture of the local context. Including indirect emissions, the interpretation of a result or of a trend is more univocal, since a low value of emissions can almost always be interpreted as *good*, and *lower* means almost always *better*.
These characteristics make protocols enforcing the responsibility principle particularly appropriate for informing and monitoring initiatives aimed at reducing emissions that are focused on local communities and are managed by local institutions, like in the Covenant of Majors initiative.
Unfortunately, since such approaches are conceived as autonomous accounting systems, overlapping and double counting issues between different areas are generally not considered, and therefore they are less suitable for spatial analysis purposes.

4 CARBON DENSITY MAPS OF THE LINEAR METROPOLITAN SYSTEM – LIMES – IN LOMBARDY: DATA AND METHODS

The availability GHG emissions data at municipality level, provided by the INEMAR project (ARPA Lombardia, 2014), has been exploited to create GHG emission density maps. The INEMAR atmospheric emission inventory, currently in its version 7.0, is a database developed in order to estimate emissions of pollutants for different activities (power production, heating, road transport, agriculture, industry, etc.). The system has been applied in the years between 2001 an 2012, and includes information from several administrative Regions in northern Italy. For the elaborations presented in this paper we have taken advantage of the final emission data for the year 2010, provided by the INEMAR database with distinct values for each of the 1546 municipalities of Lombardy.
Emissions are grouped by CORINAIR activity (group, sub-group, activity) and by fuel typology, and are available at different aggregation levels[5]. The value of greenhouse gas emissions is presented as tCO2e/y, taking into account the IPCC methodologies[6], and represents the sum of emissions weighted by the respective Global Warming Potentials (GWP).
A mapping exercise has been produced linking the INEMAR dataset with geographic data, including municipal boundaries, population data, and land-use information, produced and organized within the research PRIN 2007 *From metropolitan city to metropolitan corridor: the case of the Po Valley Corridor*.
The study, funded by the Italian Ministry of University and Scientific Research in 2007, has highlighted the urban and territorial phenomena in Northern Italy and proposed the concept of LiMeS (Linear Metropolitan System) to define the mega linear metropolitan area structured prevalently in East-West direction in the Po valley and mainly organized along the principal traffic corridor (Busi, Pezzagno, Eds. 2011). The research has identified transport, historic, traditional and new types of housing, communications, cultural tourism and leisure as major elements of the LiMeS and introduced the concept of *sprawling metropolis* as a structuring element, especially in the eastern area that is characterized by low-density expansions, determining a polycentric metropolitan area.

---

5 With reference to the categories introduced in the previous paragraph, the database considers direct emissions only: indirect (also named *shadow*) emissions, related to final energy consumption, are not estimated by INEMAR.
6 The CORINAIR - SNAP 97 subdivision/nomenclature is not the same adopted by IPCC guidelines, but this is not deemed relevant for the spatial elaborations presented in this paper.

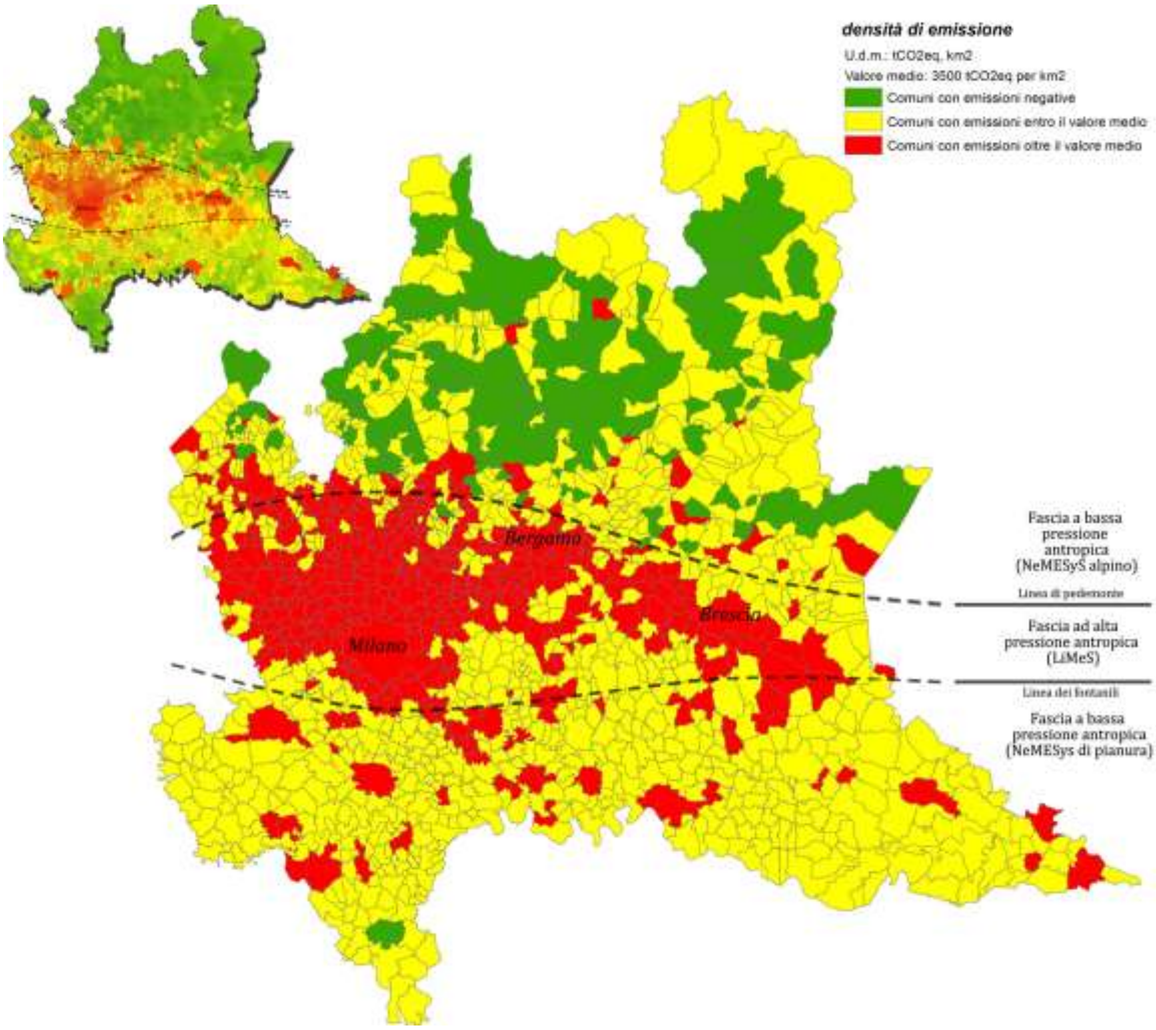


Fig. 3 Density of GHG emissions for municipality, expressed as tCO2e/km2, in the Lombardy region (2010). The gradient representation (top-left) has been forced in three classes: negative emissions, emissions up to 3,5 ktCO2e, and above

The spatial analysis of GHG emissions in Lombardy has been conducted on the relevant background of the LiMeS research: the basic structure of urban phenomena has been confirmed, and relevant information has been produced identifying specific anomalies.

The analysis has firstly considered total GHG emissions per municipality. However, the representation of absolute data within administrative boundaries can be poorly significant, if not misleading, due to the very different extension of municipalities. In order to produce a first significant picture of the metabolism of the territory at stake it is necessary to consider emissions densities, obtained dividing local GHG emissions by municipality areas.

In Figure 3 a representation of aggregate GHG emissions density for the Lombard regional area is presented. A rough classification between high, medium and negative emissions has been adopted, in order to highlight the basic distinction between high and low-anthropic pressure areas examined in depth by the PRIN research. The northern part of the region, named as the Alpine NeMESyS (Neighbouring Mega Ecological Systems) in the research cited above, is characterized by negative or low emissions, the intermediate urban LiMeS area contains the highest values, while medium values with some significant exception appear in the Plain NeMESyS.

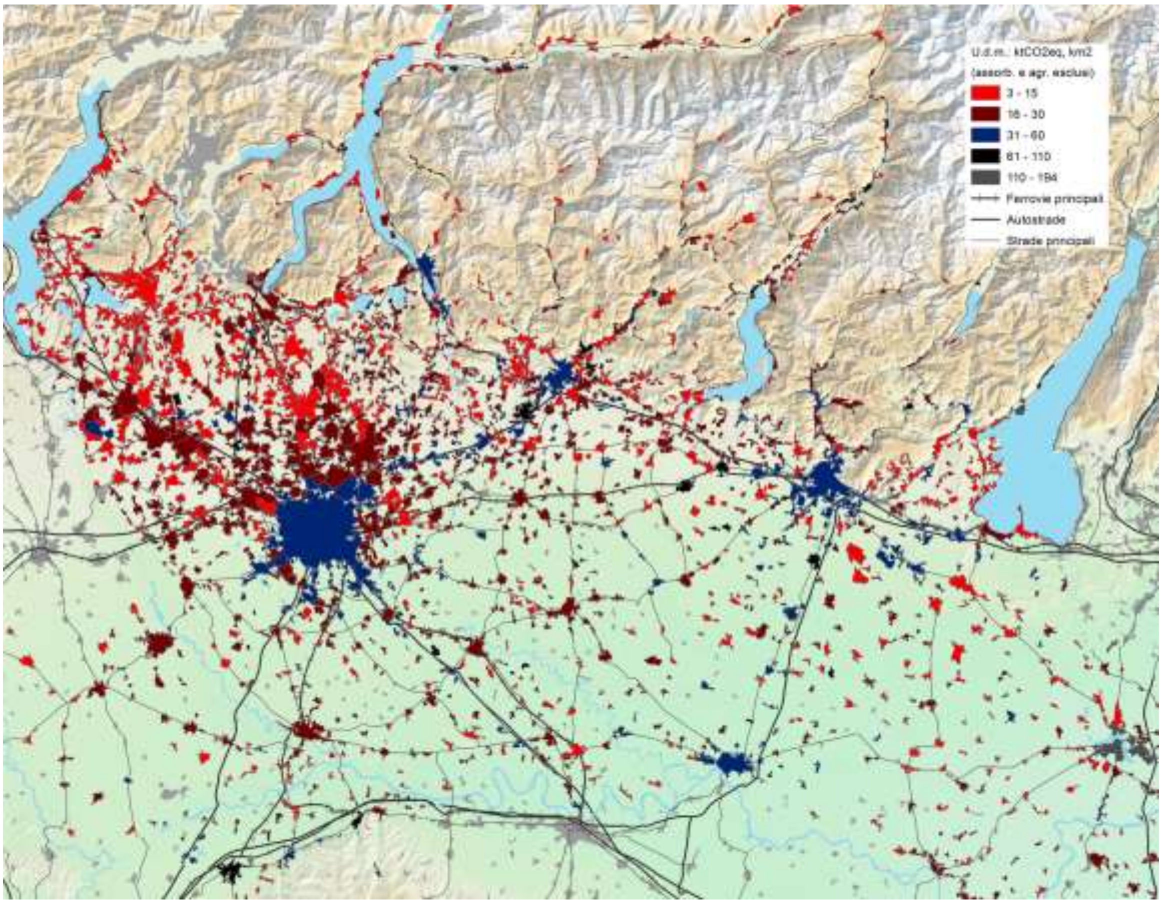


Fig. 4 GHG Emissions densities, excluding absorptions and emissions from the agricultural sector, relative to urbanized areas

The availability of disaggregated data within the INEMAR inventory (as in all IPPC-compliant emissions datasets) permits to analyse specific sectors, or to exclude them from the analysis. Taking advantage of this flexibility, the EU standard CORINE Land Cover classification has been adopted to give a first, but replicable sample of the potential insight achievable by studying the spatial correlations between sector-specific emissions and related land use classes.

In the case proposed in Figure 4, for example, the attention has been focussed on urban areas. Carbon absorptions and emissions from agriculture have been excluded (i.e. macro-sectors 10-11 of the CORINAIR classification[7]), and the resulting emissions have been mapped solely on the urbanized areas (as defined within the CORINE Land Cover classification).

The density of emissions per urbanized area significantly reflects the intensity of urban phenomena, and the resulting patterns confirm the structure of the central sector of the LiMeS. The Milan Universe characterizes the western part of the Region, with its radial propagations along the main transport infrastructures (e.g. toward the node of Bergamo), while at East the western portion of the Cenomane Dipole (Brescia-Verona) is incomplete due to the lack of data regarding the Veneto Region, but appears already intelligible. Within this general picture some significant anomalies can be identified, characterized by the highest values of emissions density (above 100 ktCO2e/km2) like in the case of Mantua, strongly characterized by the presence of a large chemical center, showing the highest values of emissions per square kilometer of the region.

In order to further enhance the perception and the understanding of exceptional values, urban emissions densities have been further elaborated, and subdivided by the number of inhabitants.

7 One of the most significant anomalies emerged in this study has been the relative weight of agricultural emissions in the southern belt of Brescia, determined by the high concentration of intensive livestock farming plants.

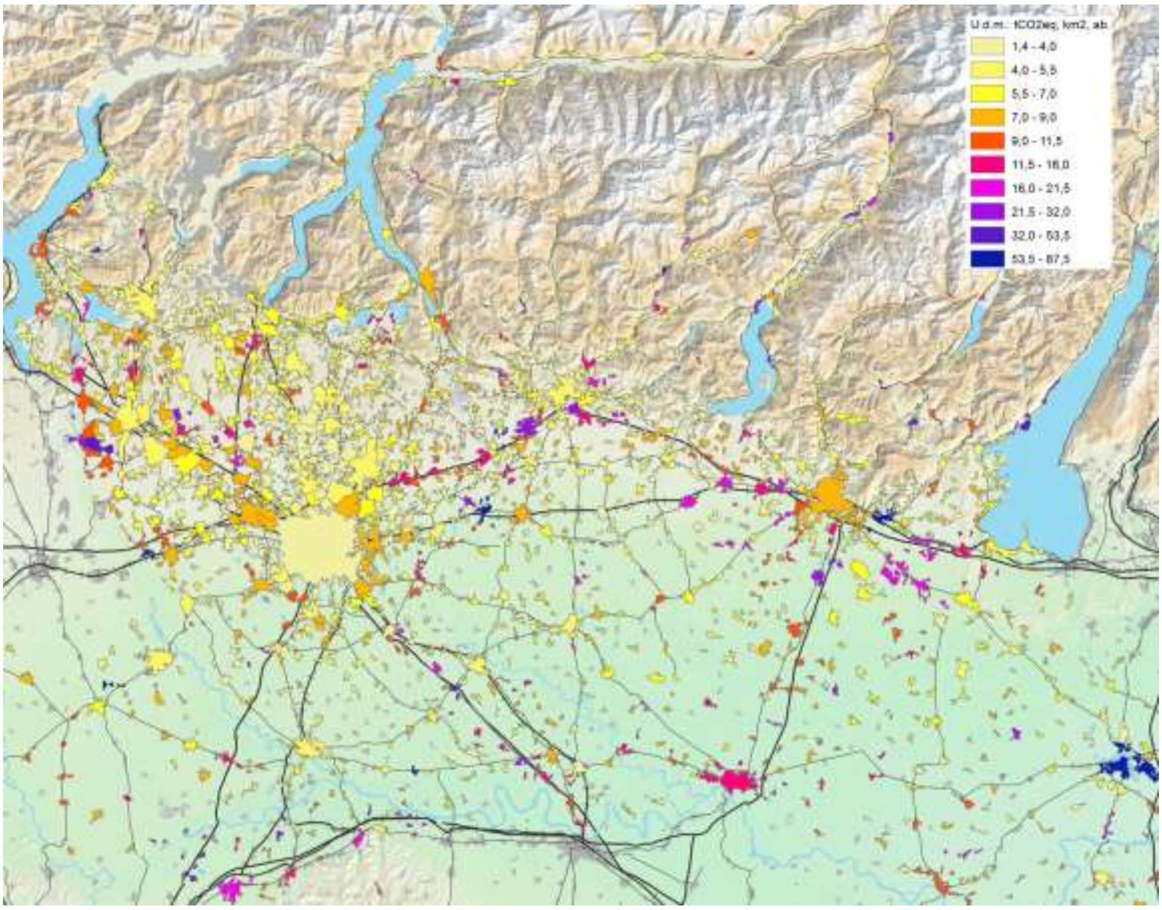


Fig. 5 Urban GHG emission densities per inhabitant: high density anomalies are represented by power plants or energy intensive industrial facilities

The resulting map, presented in Figure 5, clearly identifies an increase of emissions per inhabitant in peri-urban areas, and several, high-density anomalies that correspond to thermoelectric power plants or energy intensive industrial plants. (e.g. chemical plants, cement and paper industries).

The correlation between low-density urbanization patterns and higher per-capita emissions observed in peri-urban areas within the LiMeS is mainly driven by transport emissions[8], and confirms patterns that have been observed, applying a similar methodology, in suburbanized areas in the US (Jones, Kammen, 2013).

Considering household carbon footprints (HCF) Jones and Kammen (2013) have summed up and expressed with the common unit of GHG emissions (tCO2e/household) intensity values coming from electricity, natural gas, fuels, food, services, etc. The combined result has shown distinct carbon footprint rings surrounding urban cores, with suburbs exhibiting noticeably higher HCF, as shown in the maps reported here in Figure 6.

5 DISCUSSION: GHG EMSSION MAPS IN PERSPECTIVE

The brief GHG emissions mapping exercise proposed in Lombardy has so far confirmed behaviors and characteristics of urban systems already identified by precedent research, showing specific anomalies in correspondence with critical processes or phenomena related with large scale, energy-intense activities.

The intensity of GHG emissions per area is a viable representation of anthropic pressure on the environment that can be further detailed linking sectorial carbon emissions with land use classes.

[8] This correspondence was already observed analyzing transport costs in the cited PRIN research (Busi, Pezzagno, Eds. 2011, pag. 51).

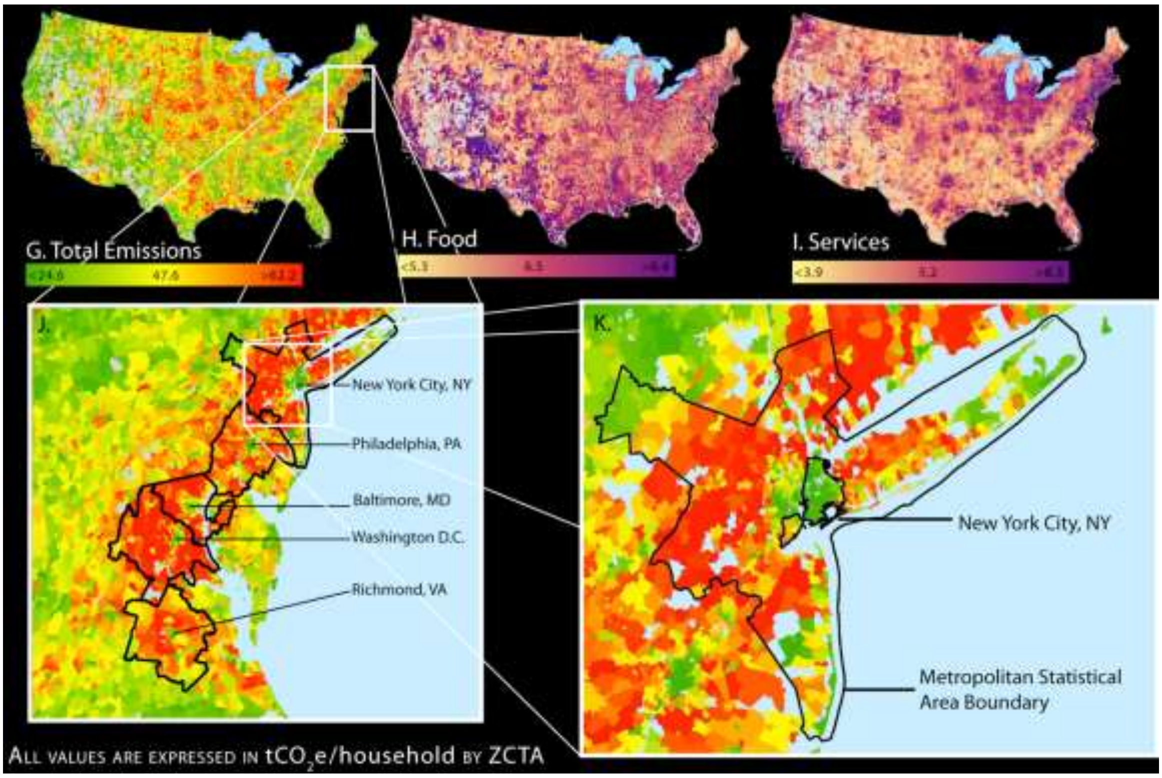


Fig. 6 Average Household Carbon Footprint - Eastern United States (Jones, Kammen, 2013)

The exclusion of emissions from the agriculture sector and the attribution of the resulting values to urbanized areas allowed a better description of urban phenomena. Within urbanized areas, the relationship between GHG emissions and population density has indicated higher carbon intensity values in correspondence with low-density settlements.

These preliminary results allow foreseeing a reasonable potential for further research, with specific regard to the development of the tool for the analysis of the metabolism of regional and local systems. With regard to smaller scales, however, it must be stressed that the higher granularity implies a level of accuracy in GHG inventories that generally cannot be provided following a top-down approach (as in the INEMAR project), in which local breakdown factors are applied starting from data harvested at the large scale.

The case of higher per-person emissions observed in lower density areas, or the case of high intensity centers identified within the LiMeS, are useful to underline the nature of the tool represented by direct emissions inventories and their spatial analysis, which require a fairly different attitude with respect – for example – to local inventories including indirect emissions.

Planners and decision makers should always approach emission density results as a signal of intensity, of consumption of resources, but also of a relevant *potential* for a transformation that always involves complex relationships between different spatial scales, infrastructures, hierarchies, and technological variables.

For example, low-density suburbs are a specific form of the city that can be considered poor regarding urban quality: i.e. mono-functional residential areas lack of socio-cultural attraction, and are difficult to target with innovative high quality public transport systems due to the low demand. However, should the ongoing advancements in distributed power generation (PV, micro wind), energy storage solutions, and electric transportation respect their promises, these settlements can be probably converted in a zero-emissions profile easier than the denser central districts. Similar considerations can be done with regard to other existing infrastructures, like the ones evidenced in emission hotspots determined by thermal power plants: should power-to-gas technologies[9] become the main strategy for long-term energy storage in the European

[9] Production of methane from peak renewable power production through water-splitting + methanation or Sabatier reactions and its storage, including relatively high percentages of hydrogen, in the gas grid.

context, and/or should fossil methane be substituted by biogas generated from agricultural waste, suddenly the entire Italian natural gas infrastructure could completely change its "meaning"[10].

Cities are complex systems that cannot be understood or defined through single-issue perspectives. Even taking into account the pervasive importance of climate change we need to improve our understanding of how GHG emissions may be managed, given the other dimensions, constraints, values and complexities of the urban system (Chester et al., 2014).

In this perspective, the integration between GHG emission inventories and land-use mapping represents a useful tool to better understand the complexity of phenomena and improve knowledge in relation to:

- achievable targets on specific topics (i.e. an emissions reduction form a specific plant or sector);
- complex policies needed in overlapping phenomena (i.e. when on the same area relevant emissions are rising from different activities / sectors without a clear profile or dominance);

toward a better use of funding and public resources and a better oriented urban regeneration.

5 CONCLUSIONS

There are unique challenges and opportunities ahead for reducing GHG emissions acting on the metabolism and on the built environment within regional and local systems. In this context the establishment of reliable representations of direct emissions at local scale can provide a common and consistent background for linking local change to the global targets defined by international goals and treaties.

We must recognize that the economy de-carbonization path ahead of us is far from being a linear or a homogeneous one. For example reducing GHG emission from urban systems in developed regions, where infrastructure is established and the capital stock turnover limited to incremental change will require solutions to different challenges than in developing regions.[11]

In this extremely complex and evolving context, local carbon emissions mapping can be represent a useful analytical tool to support the knowledge of local systems and contribute to define mitigation and adaptation policies. However, spatial mapping of direct GHG emissions should not be ingenuously interpreted and the difference with local inventories including indirect emissions should be properly addressed.

We have stressed the importance of considering GHG spatial mapping as a *tool* for producing a very general knowledge: a thermodynamic *proxy*, meaning an indicator of the intensity of the processes occurring in a local system, without implicit goal functions, which represents a starting point for further research and for pursuing appropriate mitigation strategies.

In this perspective, and taking into account the dimensional limits of top-down inventories at the smaller scales, the tool can be profitably used as a low-level reference, the much-needed common and consistent background for linking local change to global de-carbonization pathways.

In conclusion, spatial mapping should cautiously be considered a discipline in its early stages of development, with an interesting potential for supporting spatial planning and mitigation policies at regional and local scale.

[10] Fast modulating thermal power plants, together with pumped hydro plants, can play a vital role in grid short and long-term stability in a power generation scenario with high content of intermittent renewable sources.

[11] The greatest opportunity for configuring cities for low GHG emissions may be in developing regions. The majority of urbanization in the next 50–100 years will be occurring in medium-sized towns in Asia and Africa. As half of urban land in existence in 2030 is yet to be developed the next decades offer a critical window of opportunity to influence how cities are built. The way that these cities urbanize and the type of infrastructure developed will have large impacts on GHG emissions in the future (Chester et al., 2014).

REFERENCES

ARPA Lombardia. (2014). *INEMAR, Inventario Emissioni in Atmosfera: emissioni in Regione Lombardia nell'anno 2010 - dati finali.* ARPA Lombardia Settore Monitoraggi Ambientali.

Bastianoni, S., Pulselli, F. M., & Tiezzi, E. (2004). The problem of assigning responsibility for greenhouse gas emissions. *Ecological Economics*, *49*(3), 253–257. doi:10.1016/j.ecolecon.2004.01.018

Bastianoni, S., Marchi, M., Caro, D., Casprini, P., & Pulselli, F.M. (2014). The connection between 2006 IPCC GHG inventory methodology and ISO 14064-1 certification standard – A reference point for the environmental policies at sub-national scale. *Environmental Science & Policy*, *44,* 97-107.

Berni, A. (2013). Primi approcci all'analisi delle emissioni di gas serra. Il caso di studio di Brescia. Tesi di Laurea, Corso di Laurea Specialistica in Ingegneria Edile-Architettura, Relatrice Arch. Michèle Pezzagno, Correlatore Arch. Marco Rosini, Anno Accademico 2013-2014.

Bréon, F. M., Broquet, G., Puygrenier, V., Chevallier, F., Xueref-Remy, I., Ramonet, M., … Ciais, P. (2015). An attempt at estimating Paris area CO2 emissions from atmospheric concentration measurements. *Atmos. Chem. Phys., 15*(4), 1707–1724. doi:10.5194/acp-15-1707-2015

Brunner, P. H. (2011). Urban Mining A Contribution to Reindustrializing the City. *Journal of Industrial Ecology*, *15*(3), 339–341. doi:10.1111/j.1530-9290.2011.00345.x

Busi, R., & Pezzagno M. (Eds.) (2011). Una città di 500km. Letture del territorio padano. Roma: Gangemi editore.

Chester, M. V., Sperling, J., Stokes, E., Allenby, B., Kockelman, K., Kennedy, C., … Hendrickson, C. T. (2014). Positioning infrastructure and technologies for low-carbon urbanization. *Earth's Future*, *2*(10), 533–547. doi:10.1002/2014EF000253

Daly, H.E. (1973). Toward a Steady-state Economy. London: W.H.Freeman & Co Ltd.

Duren, R. M., & Miller, C. E. (2012). Measuring the carbon emissions of megacities. *Nature Clim. Change, 2(8),* 560–562. doi:10.1038/nclimate1629

Effetto Serra nel territorio della Provincia di Siena. (GHG inventory - ISO 14064 certification).

Fistola R., & La Rocca R. A. (2014). New Technologies for Sustainable Energy in the Smart City: the Wet Theory, *TeMA Journal of Land Use Mobility and Environment, 7*(1), 29-42. doi: 10.6092/1970-9870/2267

Galderisi, A., & Ferrara, F. (2012). Enhancing urban resilience in face of climate change: a methodological approach. *Tema. Journal Of Land Use, Mobility And Environment,* 5(2), 69-88. doi: 10.6092/1970-9870/2267

ICLEI. (2012). *Global Protocol for Community-Scale Greenhouse Gas Emissions*, C40 Cities Clim. Leadership Group, ICLEI Local Gov. for Sustainability, World Resources Inst., World Bank, UNEP, and UN-HABITAT, Bonn, Germany.

IPCC. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC. (2007). *Climate Change 2007—The Physical Science Basis: Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC. (2014a). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC. (2014b). *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Fong, W.K., Sotos, M., Doust, M. Schultz, S., Marques, A., Deng-Beck, C., (2014). *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)*. World Resources Institute.

Jones, C., & Kammen, D. M. (2013). Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density. *Environmental Science & Technology*, *48*(2), 895–902. doi:10.1021/es4034364

JRC. (2014). *Further slowdown in the increase in global CO2 emissions in 2013.* (Report 93171 / PBL report 1490). The Hague: PBL Netherlands Environmental Assessment Agency.

Munksgaard, J., & Pedersen, K. A. (2001). CO2 accounts for open economies: producer or consumer responsibility? *Energy Policy*, *29*(4), 327–334. doi:10.1016/S0301-4215(00)00120-8

National Geographic. (2014). Interactive Map: Four Ways to Look at Carbon Footprints. Retrieved March 24, 2015, from http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/global-footprints/

Olivier, J.G.J., Janssens-Maenhout, G., Muntean, & Peters, M. (2014). *Trends in global CO2 emissions - 2014 report*. The Hague: PBL Netherlands Environmental Assessment Agency.

Papa, R., Gargiulo, C., & Zucaro, F. (2014a). Climate change and energy sustainability. Which innovations in European strategies and plans. *TeMA. Journal of Land Use, Mobility and Environment.* Special Issue: Eighth International Conference INPUT Smart City - Planning for Energy, Transportation and Sustainability of the Urban System. Naples, 4-6 June 2014. doi:10.6092/1970-9870/2554

Papa, R., Gargiulo, C., & Zucaro, F. (2014b). Urban systems and energy consumptions: a critical approach. *TeMA. Journal of Land Use, Mobility and Environment.* Special Issue: Eighth International Conference INPUT Smart City - Planning for Energy, Transportation and Sustainability of the Urban System. Naples, 4-6 June 2014. doi:10.6092/1970-9870/2552

Pezzagno, M., & Rosini, M. (2014). Entropy and the city. GHG emissions inventory, a common baseline for the design of urban and industrial ecologies. *TeMA. Journal of Land Use, Mobility and Environment.* Special Issue: Eighth International Conference INPUT Smart City - Planning for Energy, Transportation and Sustainability of the Urban System. Naples, 4-6 June 2014. doi:10.6092/1970-9870/2520

IMAGE SOURCES

Cover image: free composition with the INEMAR inventory basic formula, considering emissions from activities for relative emission factors. Background image, eclipse from NASA Solar Dynamics Observatory (SDO); Front, nocturnal image of northern Italy – with the LiMeS urban system highlighted – from the ISS. Credits ESA/NASA.

Fig. 1: EDGAR inventory 4.0 - http://edgar.jrc.ec.europa.eu/part_CO2.php

Fig. 2: ICLEI. (2014)

Fig. 3, 4, 5: Berni, A. (2013)

Fig. 6: Jones, Kammen. (2013)

AUTHORS' PROFILES

Michele Pezzagno

Architect, Assistant professor in Town and regional planning, DICATAM – University of Brescia. Member of the PhD board in "Civil and environmental engineering". Her research studies mainly deal with life quality in urban areas, road safety and urban renewal, focusing on contemporary cities and metropolises.

Marco Rosini

Architect, temporary research fellow, DICATAM – University of Brescia. After the studies in architecture and urban planning has earned his PhD in Chemistry at the University of Siena. His research studies are focused on materials and energy flows within the urban context and in relationship with the environment.

TeMA
Journal of
Land Use, Mobility and Environment

TeMA 1 (2015) 19-49
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2883

review paper received 20 January 2015, accepted 23 April 2015

www.tema.unina.it

How to cite item in APA format:
Papa, R., Galderisi, A., Vigo Majello M.C., Saretta E. (2015). Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 19-49. doi:http://dx.doi.org/10.6092/1970-9870/2883

SMART AND RESILIENT CITIES

A SYSTEMIC APPROACH FOR DEVELOPING CROSS-SECTORAL STRATEGIES IN THE FACE OF CLIMATE CHANGE

ROCCO PAPA[a], ADRIANA GALDERISI[b],
MARIA CRISTINA VIGO MAJELLO[c], ERIKA SARETTA[d]

[a,b,c,d] Department of Civil, Architectural and Environmental Engineering (DICEA) - University of Naples Federico II
e-mail: [a]rpapa@unina.it, [b]galderis@unina.it,
[c]vigo.majello@unina.it, [d]erika.saretta@unina.it
URL: [a]www.roccopapa.it, [b,c,d]www.dicea.dip.unina.it

ABSTRACT

Climate change is considered one of the main environmental issues challenging contemporary cities. Meanwhile, urban development patterns and the growth of urban population represent the main contributors to climate change, affecting the total energy consumptions and the related greenhouse gas emissions. Therefore, a breakthrough in current urban development patterns is required to counterbalance the climate-related issues.
This study focuses on the Smart City and Resilient City concepts that, according to current scientific literature, seem to play a leading role in enhancing cities' capacities to cope with climate change.
In detail, based on the review of existing literature, this study analyzes the synergies between the two concepts, highlighting how the Smart City concept is more and more widely interpreted as a process addressed to make cities "more livable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Nevertheless, current initiatives to improve cities' smartness and resilience in the European cities are very fragmented and operational tools capable to support multi-objective strategies are still at an early stage.
To fill this gap, embracing a systemic perspective, the main characteristics of a smart and resilient urban system have been identified and framed into a conceptual model. The latter represents a preliminary step for the development of an operational tool capable to guide planners and decision-makers in carrying out multi-objective strategies addressed to enhance the response capacities of complex urban systems in the face of climate change.

KEYWORDS:
smart city, resilient city, systemic approach, climate change, climate adaptation

TeMA
有关土地使用、交通和环境的杂志

TeMA 1 (2015) 19-49
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2883

review paper received 20 January 2015, accepted 23 April 2015

www.tema.unina.it

How to cite item in APA format:
Papa, R., Galderisi, A., Vigo Majello M.C., Saretta E. (2015). Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 19-49. doi:http://dx.doi.org/10.6092/1970-9870/2883

智能与弹性城市

为应对气候变化制定跨部门战略的系统方法

ROCCO PAPA[a], ADRIANA GALDERISI[b],
MARIA CRISTINA VIGO MAJELLO[c], ERIKA SARETTA[d]

[a,b,c,d] Department of Civil, Architectural and Environmental Engineering
(DICEA) - University of Naples Federico II
e-mail: [a]rpapa@unina.it, [b]galderis@unina.it,
[c]vigo.majello@unina.it, [d]erika.saretta@unina.it
URL: [a]www.roccopapa.it, [b,c,d]www.dicea.dip.unina.it

摘要

气候变化被视为对当代城市构成挑战的主要环境问题之一. 同时,城市发展模型与城市人口的增长是气候变化的主要原因, 影响着总能耗与相关的温室气体排放. 因此,为解决气候有关的问题题,需要当前的城市发展模型实现突破.
本研究聚焦于“智能城市”与“弹性城市”的概念;具体而言,本研究以现有文献回顾为基础, 分析了这两个概念之间的协同增效, 强调了智能城市的概念如何越来越广 泛地被诠释成使城市“更宜居、富有弹性, 因此能够更快速地应对新挑战”的过程(Kunzmann,2014). 然而, 当前欧洲各城市提高城市智能与弹性的举措过于碎片化能够支持多目标战略的运营工具尚处于早期阶段为填补这一空缺, 通过采取系统方法 智能弹性城市系统的主要特征已经得到识别并被 整合为一个概念模型. 后者代表了运营工具开发 的初步阶段, 该工具能够指导规划者与决策者落 实多目标战略, 以提高复杂城市系统对于气候变化的响应能力.

关键词
智能城市, 弹性城市, 系统方法,气候变化,
气候适应!

1 INTRODUCTION

According to the available trends and projections (UN, 2014), urban population has overcome the rural one since 2005 and it is expected to further increase by 2050. Even though cities represent only the 4% of the Earth's land (UNEP, 2014), they consume about the 67% of the global primary energy (IPCC, 2014) and, due to urban lifestyle and economy, they are responsible for more than the 70% of greenhouse gas (GHG) emissions (Birkmann et al. 2010; EU, 2011) that are, in turn, the main contributors to climate change. Thus, according to current trends, the expected growth of urban population will further increase energy consumptions, worsening the current energy scenario. Moreover, the "continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system" (IPCC, 2013), with effects that will be particularly severe in urban areas, due both to the concentration of people, assets and strategic activities and to the peculiarities of cities that may exacerbate the impacts of the heterogeneous climate-related phenomena.

Fortunately, cities can be interpreted as "cauldrons of diversity and differences and as fonts for creativity and innovation" (Florida, 2003): therefore, although playing a major role in the creation of current environmental challenges, they can be considered as a central part of any response.

Thus, mitigation strategies, addressed to reduce energy consumptions, combined with adaptation strategies, aimed at counterbalancing climate-related impacts, represent crucial challenges that cities have to deal with, in order to guarantee a sustainable urban environment for the rapidly growing urban population. Indeed, on the one hand, mitigation actions can allow the reduction of CO_2 emissions and, consequently, of climate-related impacts on urban areas. On the other hand, adaptation actions can enhance urban capacities to cope with unavoidable impacts of climate change (fig.1).

The issues related to the reduction of energy consumptions and to the urban adaptation to climate change have been considered as crucial in most of the recent metaphors related to urban development and addressed to improve cities capacities to cope with urgent environmental challenges (Moir et al., 2014): eco-cities, low-carbon cities, transition cities, smart cities, resilient cities represent only some examples.

We will focus here on the metaphors of "smart" and "resilient" cities, which seem to play a leading role due both to the growing attention paid by scholars all around the world to these terms and to the increasing number of on-going initiatives both on the global and on the European scale.

In detail, according to some scholars, 40 global cities will become smart by the year 2020 (EIP, 2014) and by 2025 the number of Smart City all around the globe will climb from 21 of the 2013 up to 88 (Smart City Council, 2014a).

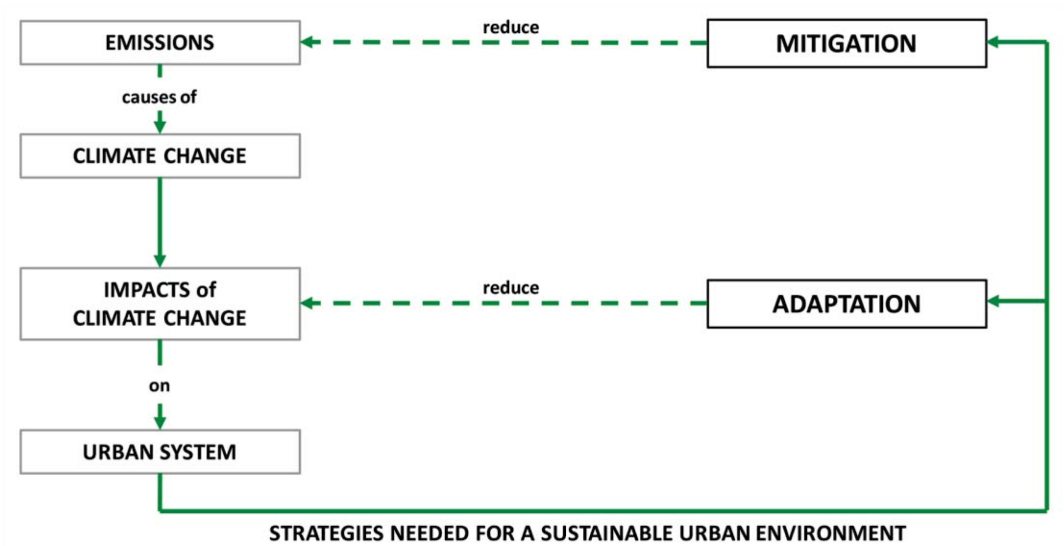


Fig. 1 Relations between urban system, climate changes, mitigation and adaptation (elaborated by Füssel et al., 2006)

Moreover, the European Commission has launched the European Innovation Partnership for Smart Cities and Communities for supporting "energy production, distribution and use; mobility and transport; and information and communication technologies (ICT)" to "improve services while reducing energy and resource consumption and greenhouse gas emissions" (EIP, 2013). Meanwhile, about 2100 cities all over the world have joined the "Making Cities Resilient" Initiative, launched in 2010 (UNISDR, 2012a) and, in December 2014, 100 cities have been selected by the Rockefeller Foundation Initiative for the "100 Resilient Cities Challenge" (Rockefeller Foundation, 2015). In Europe, a strategy addressed to enhance cities' adaptation to climate change in order to realize a "more climate-resilient Europe" has been established (EU, 2013) and the "LIFE+ Program" focused on urban resilience (EU LIFE, 2014) has been launched.

Despite the numerous on-going initiatives, both Smart City and Resilient City are still vague and fuzzy concepts. In the case of the Smart City, about 30 definitions have been proposed since 2000 (Caragliu et al., 2009). In current literature a Smart City is generally characterized by the wide use of Information and Communication Technologies (ICTs) for traditional infrastructures as well as for improving the active participation of human and social capital (Caragliu et al., 2009; Toppeta, 2010; Dameri, 2013). Such technology-based approach is often considered capable of dealing with different urban problems (Batty et al., 2012; Lee et al., 2013), guaranteeing both the quality of the urban environment and the sustainability of its development. On the opposite, it is worth noting that not many definitions of Resilient City have been provided even though the concept of resilience – developed since the Seventies – seems to be particularly suitable for urban areas (Galderisi, 2014). Focusing on the resilience concept, some authors emphasize that resilience is "in danger of becoming a vacuous buzzword from overuse and ambiguity" (Rose, 2007), "increasingly viewed in a rather vague and malleable meaning" (Brand and Jax, 2007). Notwithstanding, some organizations agree on a definition of a Resilient City as a city capable to withstand or absorb the impact of hazards, shocks and stresses through adaptation or transformation, in order to guarantee a long-term sustainability, as well as its basic functions, characteristics and structures (UNISDR, 2012b; ICLEI, 2014a; Resilient City, 2014).

Thus, based on the review of existing literature and embracing a systemic perspective, this contribution will highlight synergies and mismatches between the two concepts, identifying the main characteristics of a smart and resilient urban system and framing them into a conceptual model, showing the relationships between these characteristics and outlining the processes for building up smart and resilient cities, according to different temporal perspectives, from short to long-term.

This study represents a first step for shifting from current "silo" approaches - based on the fragmentation of knowledge, strategies and responsibilities (EEA, 2014) - towards a systemic one. Such an approach could better support cross-sectoral strategies and multi-objective actions, more and more crucial in the face of climate change in an era of limited public resources, for enhancing the capacities of complex urban systems to deal with more and more interconnected challenges.

2 SMART AND RESILIENT CITIES: TOWARDS NEW PARADIGMS?

Currently, Smart City and Resilient City are drawing an increasing attention by urban planners, decision-makers and municipalities, as shown by the proliferation of academic researches, as well as of institutional initiatives on these topics. Thus, Smart City and Resilient City are becoming widespread labels, despite the lack of shared definitions.

Approaching the terms, the first issue arising refers to their definition as concept or paradigms: some scholars indeed refer to the Smart City as a paradigm (Auge et al. Blùm, 2012; New City Foundation, 2014; Bencardino and Greco, 2014), while others consider it as a concept (Washburn, 2011; Cretu, 2012; Dameri, 2013; BSI, 2013; EIP, 2013). It is worth noting that also halfway positions exist, looking at the Smart City as an emerging paradigm (Kunzmann, 2014). The Resilient City is a recent term based on resilience that some scholars define as a concept (Rose, 2007; Davoudi, 2012) or even as a "new umbrella concept", able to take into account "risk management, ecological, sustainability or political sciences" (Chelleri, 2012), while others as a paradigm (Ercoskun, 2012; Rogers et al., 2012).

It has to be underlined that a paradigm can be defined as a "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1970); whereas a scientific concept is generally represented through three parts: a label, a theoretical definition that permits "others to understand our theory and be able to criticize and reproduce our observations" and an operational definition that "translates the verbal meaning provided by the theoretical definition into a prescription for measurement" (Suppe, 1997).

Hence, due both to the lack of a shared scientific definition of the two terms and to the heterogeneity of city programs and initiatives addressed to improve urban smartness and/or resilience, it seems hard to define them as paradigms: both Smart City and Resilient City contribute in offering solutions and opportunities for urban problems but, so far, they do not represent a "universally recognized scientific achievements". On the opposite, they can easily considered as concepts: both of them are more and more used as urban labels (Hollands, 2008; Caragliu et al., 2009; Davoudi, 2012), numerous definitions of each term are currently available and, even though their operational definition is still at an early stage, some basic elements have been developed, such as domains (for the Smart City concept), characteristics and indicators.

Thus, according to such interpretation, definitions, evolution paths and goals of the two concepts will be reviewed and compared, highlighting their synergies and mismatches, as a starting point to develop an integrated operational approach to Smart City and Resilient City.

The Smart City concept has gained an increasing attention, in the last decade, by scholars, practitioners and decision-makers in conferences, scientific and political meetings, even though "a clear-cut, common definition of smart cities is still lacking" (Moser et al., 2014). The attention paid to this concept since the 2000 has significantly increased, not only in the scientific arena, as clearly highlighted by the search query data from Google Trends (fig.2), which provides information about how often, all over the world, a particular search-term is entered in respect to the total search-volume.

Studies and researches on Smart City developed in the last years, arising from different disciplinary fields and perspectives (academic, industrial, institutional) and focusing on different topics, have led to a number of heterogeneous definitions.

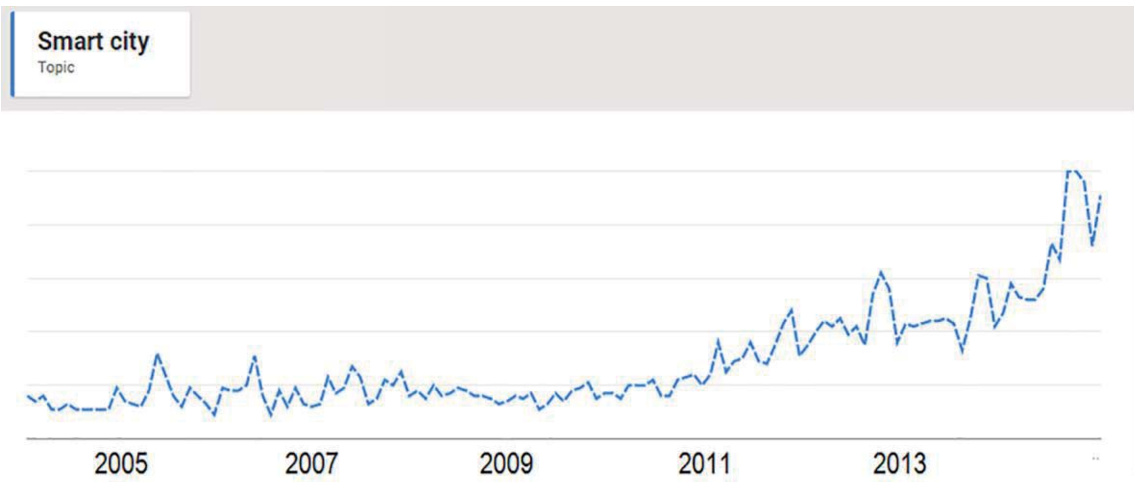


Fig. 2 Google Trends for "Smart City"

Some of them focuses on environmental issues, paying large attention to the efficient use of natural resources and to energy consumptions (EIP, 2013; Karnouskos et al., 2013, Kramers et al., 2014); others on socio-economic issues, highlighting the importance of social and human capital (Moser, 2001; Florida, 2003; Partridge, 2004; Glaeser and Berry, 2006; Giffinger et al., 2007; Dirks et al., 2010); others on institutional aspects, emphasizing the potential of ICTs in improving current decision-making processes and supporting the empowerment of local communities (Coe et al., 2001; Eger, 2009; Paskaleva, 2009).
Nevertheless, although the large variety of studies and researches focuses on different aspects, they agree on the crucial role of ICTs (Mosannenzadeh and Vettorato, 2014), assigning to technology different weights, according to the different disciplinary perspectives. Summing up, the numerous definitions of Smart City currently available bring out a variety of approaches and interpretations of the concept, although this multiplicity can be effectively reduced to two broad categories:

- a first one comprises the definitions referred to a "technology-based" approach, mainly focused on urban physical infrastructures (e.g., Hall, 2000; STERIA, 2011; Lazaroiu and Roscia, 2012; Aoun, 2013)
- a second one includes the definitions based on a holistic approach to the Smart City, capable to take into account the numerous and interconnected components that characterize an urban system (e.g., Giffinger et al., 2007; Nam and Pardo, 2011; Lee et al., 2013; Papa et al., 2013).

Among the numerous collected and analyzed definitions (approximately 30), the most relevant ones have been selected (Tab. 1), based on the number of quotations of the article comprising such definitions reported by Google Scholars. It is worth noting that all the selected definitions, which represent the most cited ones, refer to the second category. According to some scholars (Moir et al., 2014), also the "Resilient Cities is a concept growing in use". The term appeared in 2002 in the "Resilient Communities Program Concept" and it was used by Pickett et al. (2004) as a "*metaphor (...) to help link ecology and planning*".

Reference	**Definition**	**Citations**
Caragliu et al. 2009	We believe a city to be 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.	358
Komninos N. et al., 2011	The Smart Cities concept (...) is connected to notions of global competiveness, sustainability, empowerment and quality of life, enabled by broadband networks and modern ICTs.	291
Giffinger R. et al., 2007	A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens.	207
Nam T., Pardo T.A., 2009	Smart city integrates technologies, systems, infrastructures, services, and capabilities into an organic network that is sufficiently complex for unexpected emergent properties to develop.	103
Odendaal N., 2003	A smart city or region (...) is one that capitalizes on the opportunities presented by Information and Communication Technology (ICT) in promoting its prosperity and influence.	93
Batty M. et al., 2012	A Smart City is a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies. Smart cities are also instruments for improving competitiveness in such a way that community and quality of life are enhanced.	87

Tab.1 Smart City Definitions

The term was largely widespread thanks to the book edited by Vale and Campanella (2005) and titled "The Resilient City". The volume focused on the persistence of cities in the face of disasters and namely on their capacity to "rebound from destruction", being the cities "among humankind's most durable artifacts". Nevertheless, only recently the term "Resilient City" is gaining importance both in scientific debate and on the institutional level. Indeed, the Google Trends query for "Resilient City" (Fig. 3) highlights that the term entered the search queries in 2012, after the Sandy Hurricane that caused about 19 billion dollars of total damage. Such trend is arguably related to the priorities of national and local governments, which - in the face of the human and economic losses due to climate-related events - pushed towards the adoption of strategies and initiatives aiming at enhancing urban resilience, thereby promoting studies and research on this issue.

Also for the Resilient City concept, heterogeneous definitions are available; some of them have been provided by scholars (Newman et al., 2009; Fusco Girard et al., 2012), others by institutions (UNISDR, 2012a), large international organizations (World Bank Group, 2011) or private foundations (Rockefeller Foundation, 2015). Nevertheless, all the available definitions agree on the main idea that a resilient city is a city capable to absorb external pressures or to adapt or transform in front of such pressures, guaranteeing the safety of settled communities and the preservation of its basic functions during a crisis. Referring to the same temporal span, it is worth noting that the total number of definitions of the term Resilient City that can be found in current literature is by far lower than those available for Smart City. The most quoted definitions or the most widespread on the international level are shown in Table 2. Nevertheless, it has to be underlined that despite the definitions of Resilient City are fewer than those related to the Smart City, this concept roots in the wide research field focused on resilience, and namely on the resilience of social-ecological systems (Adger et al., 2005; Folke, 2006; Brand and Jax, 2007), to which a growing attention has been paid since the 2000 (Fig. 4). Numerous studies and researches have been carried in the last decades on the resilience of socio-ecological systems in the face of heterogeneous pressure factors, such as:

- natural hazards/climate change (e.g., Sapountzaki, 2010; Bahadur et al. , 2010; Jabareen, 2013; IPCC, 2013; Galderisi, 2014);
- energy consumptions and oil dependency (e.g., Newman et al., 2009; Hopkins, 2008; North, 2010);
- economy (e.g., Rose, 2007; Drobniak, 2010; Simmie and Martin, 2010).

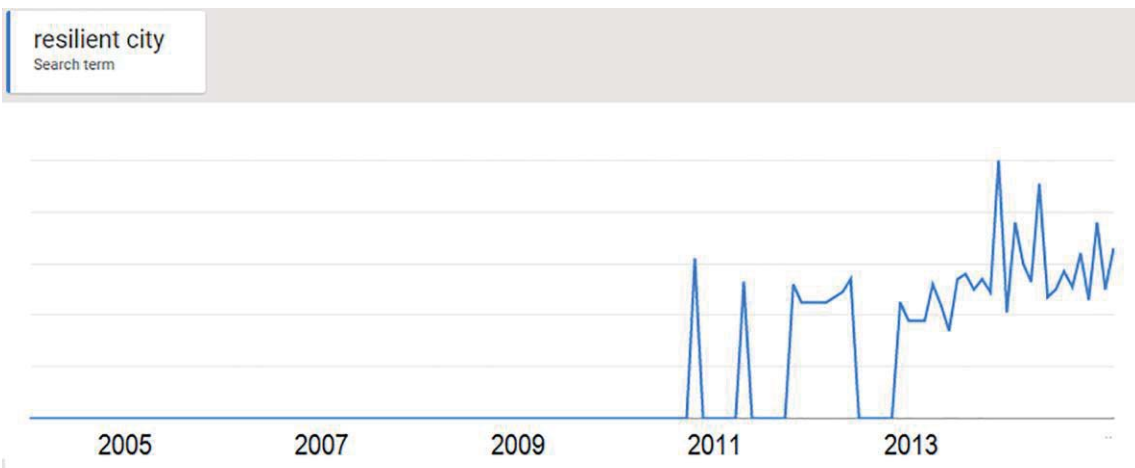


Fig. 3 Google Trends for "Resilient City"

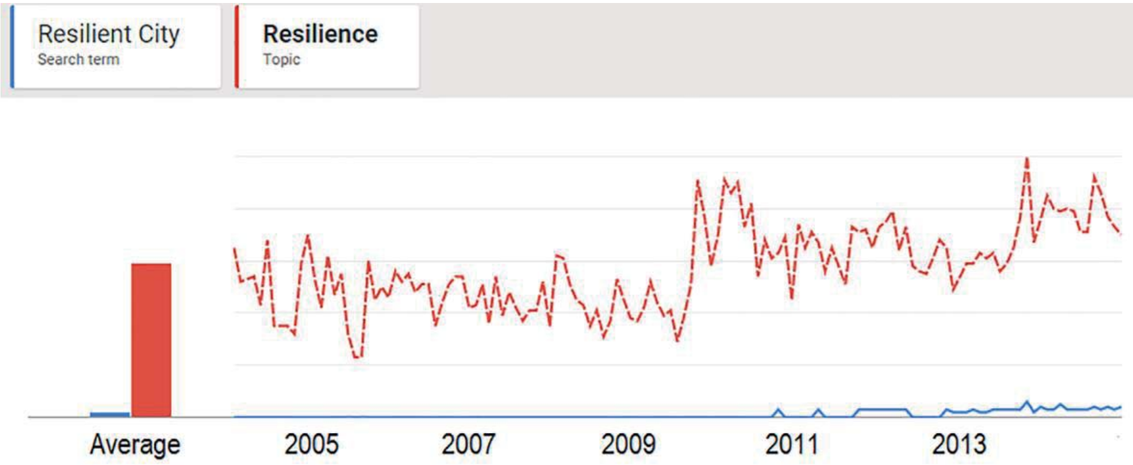


Fig. 4. Google Trends for "Resilience" (red) and for "Resilient City" (blue)

However, here we will refer only to the definitions of Resilient City, purposely neglecting the numerous and heterogeneous definitions of resilience, in order to allow a more immediate comparison with the Smart City definitions. Similarly to the case of Smart City, even in the most commonly used definitions of Resilient City there is a tendency to take into account different disciplinary perspectives, considering social, economic and environmental factors and their interrelationships as a key for an effective understanding of the complexity of urban systems and namely of their behaviors in the face of heterogeneous pressures. Briefly, according to the proposed definitions, the Smart City is a widespread label underlying a vision of the city based on the potential of ICTs as a key tool "to fuel sustainable economic growth and a high quality of life" (Caragliu et al., 2009).
The Resilient City promotes a vision of the city in which efforts are addressed to increase the ability of the city to respond to heterogeneous pressure factors (climate, environmental, energy and economic), with the ultimate aim of ensuring a higher quality of life and sustainable urban development. Furthermore, numerous scholars point out that ICTs, key tools for increasing urban smartness, could play a significant role also in reducing urban vulnerability and improving cities' resilience.

Reference	Definition	Citations
Newman et al., 2009	Resilient cities have built-in systems that can adapt to change, such a diversity of transport and land-use systems and multiple sources of renewable power that will allow a city to survive shortages in fuel supplies.	344
Nijkamp P. et al., 2012	A resilient city is also a creative city, able to reinvent a new equilibrium against destabilizing external pressure. It multiplies the potential of people to build new opportunities/alternatives.	13
Resilient Communities Program Concept, 2002	Resilient City is a city that supports the development of greater resilient in its institutions, infrastructure and social and economic life. Resilient cities reduce vulnerability to extreme events and respond creatively to economic, social and environmental change in order to increase their long- term sustainability.	n.a.
UNISDR, 2012	A resilient city is characterized by its capacity to withstand or absorb the impact of a hazard through resistance or adaptation, which enable it to maintain certain basic functions and structures during a crisis, and bounce back or recover from an event.	n.a.

Tab.2 Resilient City Definitions

According to Heeks et al. (2013), indeed, “ICTs can help strengthen the physical preparedness of communities by helping those communities to optimize the location of physical defenses” and “can also strengthen institutions needed for the system to withstand the occurrence of climatic events”.
Summing up, the analysis and the comparison among the definitions of Smart City and Resilient City highlight important commonalities between the two concepts, even though the lack of clear-cut common definitions and the fact that both concepts are still evolving make a conclusion still open and harbinger of future research developments.

3 THE EVOLUTION OF THE SMART AND RESILIENT CITY CONCEPTS

In the previous paragraph, the definitions of the Smart City and of the Resilient City have been compared with reference to a time span ranging from the 2000 to the 2014. However, the considered definitions already refer to an end-point, although not a final one, of an evolutionary process that is far more temporally extended since the roots of each concept, can be traced in research works carried out some decades ago. Hence, to better understand current similarities and/or differences among the two concepts of Smart and Resilient City, the evolution path of each concept will be sketched, highlighting the variety of contributions arising from different disciplinary fields that contributed to building up their current meanings.
In respect to the Smart City, it is worth reminding that the term "smart" has been primarily used in the Nineties by the Smart Growth American movement, which "refers to policies for the management of growth of urban and suburban settlement and to a set of principles for designing". Moreover, the Smart Growth also refers to “an idea of the city” capable to “provide an alternative to sprawl” (Pellegrini, 2003). The movement, mainly referred to the development of new residential areas, was addressed to reduce soil consumption and sealing, promoting more sustainable developments (Moccia, 2012).
Nevertheless, the main roots of the term Smart City as it is currently interpreted “have to be traced in some of the phenomena that characterized the Eighties and the Nineties, namely, in the evolution and diffusion of ICT and in their outcomes in terms of globalization of economy and markets” (ABB-Ambrosetti, 2012; Papa et al., 2013). The term Smart City was coined at the beginning of the Nineties in order to point out an urban development more and more dependent on technology and on innovation and globalization phenomena, mainly by an economic perspective (Gibson, Kozmetsky and Smilor, 1992).
Thus, since the Nineties ICT represented a key tool for increasing efficiency, attractiveness and competitiveness of cities. Starting from the early 2000s, large industries such as Cisco, Ericsson, IBM have significantly invested in the integration of ICTs within cities, strongly supporting the spread of a techno-centered approach to the Smart City concept. Nevertheless, in the mid of the 2000s a human-centered approach, focused on the key role of the human and social capital as starting levers for a “smart” urban development, began to take shape. In the second half of the 2000s, thanks to the study of Giffinger et al. (2007), the Smart City concept gained larger room in the scientific debate. Giffinger et al. (2007) provided a model of Smart City, interpreted as “a city well performing in 6 characteristics, built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens” and a method for measuring and comparing urban smartness. The six characteristics - or, better, the sectors in which a Smart City has to ensure high performances - can be identified as follows: smart economy; smart people; smart governance; smart mobility; smart environment; smart living.
Hence, this study paved the way to an integrated approach to the Smart City concept and, based on this numerous scholars have recently provided an interpretation of the smart city as a city in which ICTs are addressed to improve the overall urban performances and, above all, the quality of life of citizens. Among them, the research work carried out by Caragliu et al., (2009), focused on the relationships among technological and social aspects, intellectual capital, health and governance issues, and the studies of Mark

Deakin (2012), who proposed the model of the "Triple Helix" for promoting social innovation, stressing on the close relationships between sustainable development and Smart City.
As a result, recently "a broader conceptualization of Smart Cities places emphasis on good city governance, empowered city leaders, smart or 'intelligent citizens' and investors in tandem with the right technology platform" (Moir et al., 2014), supporting strategies addressed to improve both "hard" (infrastructures, ICTs, etc.) and "soft" urban components (human and social capital).
As mentioned above, the term "Resilient City" gained large attention by institutions, policy makers and scholars after the Hurricane Sandy that, in 2012, hit the North Eastern part of the USA and the city of New York, causing 43 deaths and economic damage for about 19 billion dollars. In the last years, the constantly increasing popularity of the concept is mainly due to its widespread use and promotion by international organizations (eg. the UNISDR that in 2010 launched the Making Cities Resilient campaign, addressed to involve local Authorities and enhance urban resilience in the face of natural and man-made hazards); private organizations (eg. the Rockefeller Foundation, which identifies specific "challenges" that cities have to deal with - from natural hazards to social issues – promoting the initiative "100 Resilient Cities") and associations of cities and local governments (eg, ICLEI that deals with urban resilience against climate-related impacts).
Although the concept of Resilient City has recently come to the fore, the studies on resilience have been developed since the Fifties through different disciplinary fields, from physics to psychology, from ecology to management science. Referring to previous research works for an exhaustive description of the evolution path of the resilience concept (Martin-Breen and Anderies, 2011; Alexander, 2013; Galderisi, 2014), we will here point out some milestones along this path. Resilience found large room in Ecology during the Seventies, thanks to Holling (1973) that firstly focused on the behavior of natural systems in the face of external perturbations. In the mid of the Nineties, Holling provided a clear distinction between an engineering and an ecological approach to resilience. According to Holling (1996), engineering resilience refers to stability, efficiency, constancy, predictability, return time to a previous state and, above all, to the idea of a single, stable equilibrium, using "resistance to disturbance and speed of return to equilibrium (…) to measure the property". On the opposite, ecological resilience emphasizes "conditions far from any equilibrium steady state", recognizes the existence of multiple equilibrium states and can be measured according to "the magnitude of disturbance that can be absorbed before a system changes its structure". Thus, ecological resilience focuses on the twofold possibility for a system to absorb changes, maintaining its main features, below a given threshold of disturbance, or change its state, moving towards a different one, not necessarily better than the previous one, above such a threshold.
The engineering perspective has been largely widespread in the studies on risks, as opportunity for improving cities' capacities to deal with emergency and recover from disasters (e.g., IFRC, 2011; Vale and Campanella, 2005; Gunderson, 2010): according to this perspective, resilience has been interpreted as the capacity of a system to return to a previous equilibrium steady-state, to "bounce back" after disturbances.
The "ecological" approach to resilience has been significantly strengthened when the focus of studies and researches on resilience shifted from natural to socio-ecological systems and intertwined with those related to the complex adaptive systems, capable of learning from experience, processing the information, adapting and even transforming themselves in face to changes. By this perspective, resilience was less and less conceived as a bounce-back to a previous state and progressively adapted to the behavior of complex systems, that is non-linear, self-organizing, characterized by uncertainty and discontinuities (Berkes et al., 1998; Holling, 2001; Walker et al., 2004; Bankoff et al., 2004).
Recent research works have further extended the concept of resilience, defining the latter as a "dynamic interplay of persistence, adaptability and transformability across multiple scales" (Folke et al. 2010). Moreover, some scholars have pointed out the importance of "continual learning" (Cutter et al., 2008), providing an idea of resilience as 'bouncing forward', which includes the idea of 'improvement' of systems' essential structures and functions (IPCC, 2012).

Hence, current approaches to resilience seem more appropriate to grasp the complexity of urban systems' evolution (Davoudi, 2012; Chelleri et al., 2012) and suitable for framing urban policies in the face of a large set of heterogeneous phenomena, from the climate-related impacts to the scarcity of resources. In some cases, indeed, the concept of persistence, addressed to improve the capacity of a system to withstand sudden impacts and to rapidly and effectively recover previous conditions, can be significant. In other cases, being current conditions unsustainable or inadequate, novelty and innovation become crucial to drive the system's transition towards new conditions. The milestones of the evolution path of the resilience concept are shown in fig. 6; it has to be noticed that the Resilient City definitions mainly refer to the more recent interpretation of Resilience, since it is generally interpreted as a city capable to absorb, adapt and/or change in the face of external pressures. However, although the Resilient City concept is nowadays largely widespread among planners and decision makers, some scholars highlight the numerous criticalities that may arise when the resilience concept is applied to urban systems. For example, human intervention is not taken into account in the "adaptive cycle" of ecological systems, while it is crucial in case of urban systems; moreover, the need for clarifying the goals - "resilience to what ends?" – as well as the field of action - "resilience of what to what?" – and the beneficiaries - "resilience for whom?" – of policies addressed to enhance urban resilience have been largely emphasized (Davoudi, 2012).

These criticalities point out the need for improving urban resilience taking into account both "hard" and "soft" components of urban systems. The former refer to structural, technical, mechanical, and cyber systems' qualities, capabilities, and functions of infrastructures. The latter are "related to family, community, and society, focusing on human needs, behaviors, psychology, relationships, and endeavors" (Kahan et al., 2009). The difference between "hard" and "soft" components is also highlighted by some of the major networks devoted to the resilience issues (e.g., ICLEI, 2014; ACCCRN, 2012) and it is largely mirrored in the field of adaptation strategies and measures that are generally distinguished between "hard", when they "involve capital-intensive, large, complex, inflexible technology and infrastructure", and "soft", when they "prioritize natural capital, community control, simplicity and appropriateness" (Hallegatte, 2009; Sovacool, 2011).

Summing up, even though the term Smart City is rooted in the evolution and spread of ICTs and in their outcomes in terms of globalization of economy and markets, along its evolution path it has been increasingly used to indicate a city in which ICTs are addressed to improve the overall urban performances and, above all, the quality of life of citizens. The concept of resilience – which underlies the Resilient city concept – extending the concept of resilience from natural to socio-ecological and urban systems and embracing change and complexity, is more and more interpreted as a key concept for improving cities' performances in the face of the different factors currently threatening their future development, by managing a large set of interconnected properties and adaptive capacities (Norris et al., 2008; Galderisi and Ferrara, 2012).

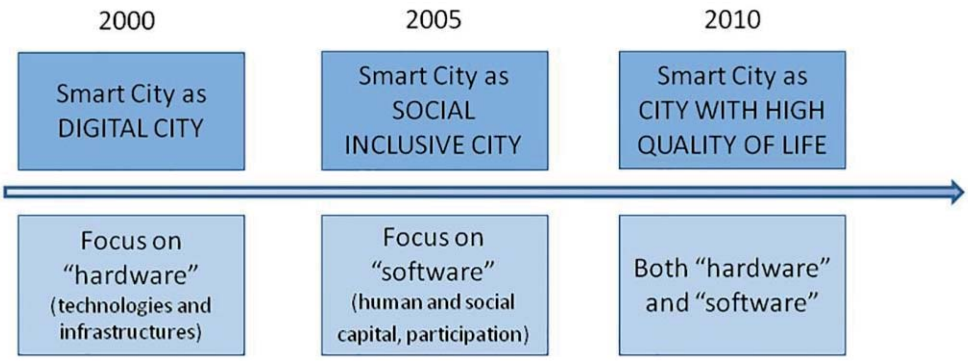


Fig. 5 Evolution of the Smart City concept

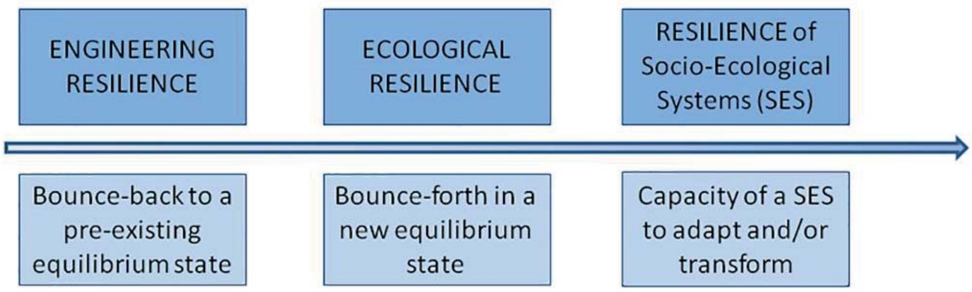


Fig. 6 Evolution of the Resilient City concept

Thus, both the concepts are currently interpreted as key concepts for improving urban performances, even though the Smart City concept puts large emphasis on the role of ICTs, while the Resilient City concept focuses on the inherent capabilities of cities to deal with the heterogeneous factors (from hazards to climate change, from environmental degradation to poverty) threatening cities' development. Moreover, both of them aim at providing strategies and measures acting on "hard" (infrastructures, technological systems, etc.) and "soft" components (capacities and behaviors of communities and institutions) of urban systems.

4 THE AIMS OF THE SMART AND RESILIENT CITY CONCEPTS

Based on the analysis of the definitions and of the evolution paths of the Smart and Resilient City concepts some commonalities between the two concepts can be outlined, even though, as clearly highlighted in the previous paragraph, each concept has its own peculiarities. To further investigate the relationships between the two concepts, the main goals of each concept have been deepened.

According to the vast scientific literature on these issues, both the Smart City and Resilient City are mainly addressed to improve sustainability and increase the quality of life, although each concept seem to pursue these objectives following different paths.

As regards sustainability, in the Smart City this goal is primarily pursued through a wide use of ICTs that, allowing a more efficient and effective management of networks (energy, transport, etc.), may led to a significant reduction in energy consumptions. In a broader sense, "a smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" (ITU, 2014).

Nevertheless, it is worth noting that the large use of ICTs may also negatively affect sustainability, at least in respect to:

- environmental aspects, in that the production of ICTs involves an intensive use of raw materials that are assembled in not recyclable devices (Wagener, 2008) and, above all, the use of ICTs induces high-energy consumption (Viitanen and Kingston, 2014). As remarked by Wagener (2007), indeed, "large cities with a high concentration of knowledge workers, office buildings, and ICT are likely to find that ICT energy use is significantly higher than national averages" (Wagener, 2007). Nevertheless, "green IT is a new emerging field of study that brings together both environmental sustainability and information technology (IT) and explores the ways in which they connect with each other" (Lombardi, 2011);
- socio-economic aspects, in that the use of "ICTs would increase the risk to human health, including stress and conflict due to inequality" (Viitanen and Kingston, 2014) among individuals and/or institutions that have access to ICT and that, above all, are able to use them properly.

Thus, according to current literature, social and environmental sustainability represent a "major strategic component of smart cities" (Caragliu et al., 2009), even though relevant aspects, such as the issues related to the potential of green ICTs or to the social inclusion, should be further investigated.

According to Folke (2002), resilience and sustainability are tightly connected concepts, due to the need for creating and maintaining prosperous social, economic and ecological systems also in the face of uncertain events. Some scholars emphasize that resilience represents a "necessary approach to meet the challenge of sustainable development" (Chelleri et al., 2012) or a way of thinking for planning sustainable cities, capable to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987).

Nevertheless, similarly to what has been highlighted for the smart city, some scholars point out some inconsistencies between resilience and sustainability (TURAS, 2012; Redman, 2014): in detail, while resilience puts large emphasis on uncertainty and discontinuities and is largely interpreted as the result of the dynamic interplay of persistence, adaptability and transformability (Davoudi, 2012), sustainability is often interpreted in a "fail-safe" approach as a concept aimed at "achieving stability, practicing effective management and the control of change and growth" (Ahern, 2011)

The increase of the quality of life is the other main goal of both Smart and Resilient City. In the Smart City, the widespread use of ICTs allows, for example, "to improve mobility on many levels, increasing spatial and a-spatial accessibilities to jobs, leisure, social opportunities and so on, thereby enabling the citizenry to increase their levels of life satisfaction" (Batty et al., 2012). Moreover, ICTs allow the reduction of energy consumptions and CO_2 emissions by allowing citizens to get a better air quality and a better environment.

The empowerment of citizens thanks to the use of ICT (Navarrete, 2012) represents a largely emphasized feature of the Smart City. It refers to a process of "social engagement" that creates a widespread sense of social cohesion, a significant awareness of the issues relevant to the community and allows people to propose and activate common objectives and actions (Zani, 2012). Thus, citizens' empowerment is a way to support decision-making processes based on a broad-base views of citizens and, therefore, to ensure development processes more participatory, collaborative and, in one, capable to effectively respond to the need of local communities.

Nevertheless, according to some scholars, "the paradox is that the same networked technologies that offer opportunities for empowerment can be used against civil rights for surveillance and censorship, or at worst, direct oppression" (Viitanen and Kingston, 2014).

Moreover, even though numerous scholars underline that the Smart City is addressed to increase "livability" (Toppeta, 2010; Chourabi et al., 2012; Smart City Council, 2014a), most of available definitions put "emphasis on business-led urban development" (Caragliu et al., 2009).

For example, the main aim of the study on European Smart Cities carried out by Giffinger et al. (2007) is to analyze the medium-sized European cities in order to find out their strengths and improve their competitiveness. The Smart City concept is, indeed, "principally open to any societal goals linked to it, but due to its focus on innovation systems, priority is given implicitly to competitiveness and economic growth" (Wolfram, 2012).

Also the Resilient City concept is addressed to increase the quality of life. A resilient city is, indeed, capable to absorb, adapt and/or change in the face of the main environmental challenges threatening its future, in order to preserve natural and man-made resources and, above all, to guarantee citizens' safety. It is worth reminding that, according to the five-stage model of human needs outlined by Maslow in 1943, safety is one of the basic needs that people have to fulfill, immediately after the biological and physiological ones. Therefore, to ensure the safety of people is a key objective for guaranteeing high levels of quality of life.

As it clearly arises from the above, the two investigated concepts, Smart City and Resilient City, show numerous commonalities, despite some differences. As regards the former, it has to be noticed that both of them result from a long and multidisciplinary evolution path capable to take into account the multiple and interrelated aspects of a complex urban systems, are addressed to pursue goals related to sustainability and quality of life and can be implemented through "hard" and "soft" measures.

Among the main differences, it is worth noting that while the spread of the Smart City concept has been strongly supported by large industries, the Resilient City concept has been mainly promoted by international organizations as well as by associations of cities and local governments.

Moreover, whereas the common ground among the definitions of Smart City can be found in the use of ICTs as a tool for empowering cities and citizens in the face of heterogeneous challenges, but above all as a key tool to fuel economic growth and competitiveness, the common ground of the definitions of Resilient City can be traced in the enforcement of the fundamental capacities of an urban system to deal with external pressures (from climate change to environmental degradation). Nevertheless, according to the more recent interpretations of the Smart City concepts, ICTs should be better addressed to solve long-term environmental challenges and to improve cities' resilience rather than primarily focus on consumer electronics. According to Heeks et al. (2013), indeed, "ICTs can help strengthen the physical preparedness of communities by helping those communities to optimize the location of physical defenses" and "can also strengthen institutions needed for the system to withstand the occurrence of climatic events".

Hence, the Smart City concept seems more and more to underlie a process, a multi-objective strategy of integrated urban and ICT development, capable to tackle problems of economic competitiveness but also of social equity and environmental performance (Wolfram, 2012). Such a process should allow cities to "become more livable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Therefore, a better integration between the two often separated concepts and following strategies seem to be widely desirable and already pursued by some. Nevertheless, such integration has to be based on a robust scientific approach capable to provide methodological and operational tools for promoting cross-sectoral and multi-objective strategies capable to improve urban smartness and resilience, by providing citizens with a better urban environment capable to favor cohesion, sense of community and, meanwhile, safety and prosperity. Moreover, it is worth emphasizing that a multi-objective strategy addressed to build up a smarter and a more resilient city should be carefully tailored on the peculiarities of local contexts, in that each city has to define its own objectives and priorities, through a shared and participatory process (BSI, 2014).

5 BUILDING UP SMART AND RESILIENT CITIES: A CONCEPTUAL MODEL

According to the preliminary findings presented in the previous paragraph, it seems possible to state that, on the one hand, the Smart City concept is widely interpreted as a process capable to tackle urban problems related to economic competitiveness but more and more focused on issues related to social equity and environmental performances (Wolfram, 2012). On the other hand, the Resilient City is largely interpreted as a process addressed to empower cities and citizens to cope with external - environmental, social, economic - pressures. Hence, due to the relevant synergies between the two concepts, some authors emphasize the increasing area of overlapping among them, highlighting that resilience is more and more frequently included among the Smart Cities' objectives and that smart initiatives are often addressed to allow cities to "become more livable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Moreover, some international organizations and networks as well as numerous cities are promoting integrated strategies for building up smarter and more resilient cities, as a key step for effectively counterbalance the challenge of climate change as well as for pursuing a better integration between mitigation and adaptation strategies (Klein et al., 2005).

For example, the American Planning Association (APA) has "created a Smart Cities and Sustainability Task Force, whose mission is to address advances in technology and innovation to cultivate cities which are smarter, more resilient and sustainable" (McMahon, 2014); the Asian Cities Climate Change Resilience Network (ACCCRN), funded by the Rockefeller Foundation, is striving for "developing smarter, resilient cities in India" (ACCCRN, 2015).

Nevertheless, as mentioned above, an effective theoretical framework – which is crucial for developing operational tools capable to support integrated and multi-objective strategies – is still missing. To fill this gap, the study focuses on the characteristics of Smart and Resilient cities and provides some hints for guiding a process aiming at improving cities' smartness and resilience in the face of climate change. In detail, based on the available scientific literature, first of all the characteristics common to both the Smart and the Resilient city concepts have been selected; then, grounding on previous studies focused on the Resilient City (Bahadur et al., 2010; Martin-Breem and Marty Anderies, 2011; Galderisi, 2013) and on the Smart City (Sinkiene et al., 2014; BSI, 2014) the most important ones for each concept have been identified. In the following (tab. 3 and 4) all the selected characteristics have been listed and briefly explained.

Resilient City Concept	Characteristic	Smart City Concept
The "capacity to maintain a system in its current stability domain" (Berkes et al., 2002)	Adaptability	The capacity to adapt to unforeseen situations (Ratti & Townsend, 2011)
"It's the ability to constantly assess, take in new information, reassess and adjust your understanding of the most critical and relevant strengths and weaknesses and other factors" (Rockefeller F., 2014)	Awareness	It is related to the capacity of knowing and understand the urban potentialities (Giffinger et al., 2007)
It refers to the existence of multiple opportunities and incentives for a broad participation of stakeholders, as in public-private partnerships (Godschalk, 2003).	Collaboration	It is related to coordination and is defined as a step of the city technology harmonization, characterized by synergies and interactions between elements, resource and actors (BSI, 2014)
It represents the achievement of higher level of functioning by adapting to new circumstances and learning from the disaster experience (Maguire & Hagan, 2007)	Creativity	It is related to the creative capital that co-determines, fosters and reinforces trends of skilled migration (Florida, 2003; Caragliu and Nijkamp, 2008)
Diversity of species performing critical functions, diversity of knowledge, institutions and human opportunity and diversity of economic supports all have the potential to contribute to sustainability and adaptive opportunity (Berkes et al., 2002)	Diversity	It can be referred to the social and ethnic plurality (Giffinger et al., 2007) or to the diversity of specific elements, e.g. transportation modes (Caragliu et al., 2009).
"Fundamental property for service system and entails that performance are realized with modest resource consumption" (Fiksel, 2003)	Efficiency	It is related to the capacity of systems and infrastructures to optimize their performances (Aoun, 2013; Kramers et al., 2014).
It is a key aspect of adaptive capacity when unexpected events occur (Godshalk, 2003) and it is the capacity of a system to cope with an impact without being permanently altered (Tasan-Kok, 2013)	Flexibility	It is the ability to change, specifically referred to labor market and human capital (Giffinger et al., 2007)

Resilient City Concept	Characteristic	Smart City Concept
"Innovation is seen as novel ways of doing things, or how new things can be made useful, and refers to incremental or radical changes in ideas, practices, and products; including novel ways of organizing society, changing its rules and institutions" (Ernstson et al., 2010)	Innovation	Changes made to something established, or a new introduction as new methods, ideas, or products, to achieve desirable outcomes that result in small but significant improvement (BSI, 2014)
Dynamic systems require to constantly revise existing knowledge to enable the management of the system and the adaptation to change (Stockholm Resilient Centre, 2014)	Learning	The human ability to gain knowledge or skill through ICT (Coe et al., 2001) or as the collection of data and their elaboration (Wolfram, 2012)
The ability to create networks of non-identical elements, or actors, called "nodes" that are connected by diverse interactions or links (Chuvarayan et al., 2006)	Networking	The capacity to connect computers and devices through communications channels that facilitate communications among users, allowing them to share resources and services (BSI, 2014)
The capacity to "build trust and relationships needed to improve legitimacy of knowledge and authority during decision making processes", as well as "create a shared understanding and uncover perspectives that may not be acquired through more traditional scientific processes" (Rockefeller F., 2014)	Participation	The capacity to involve civil society organizations, stakeholders, communities and citizens in policy-making and public debate (BSI, 2014)

Tab. 3 Common characteristics of Resilient City and Smart City

It is worth underlining that most of the literature related to the resilience of socio-ecological systems focuses on the concept of self-organization, by interpreting this concept as a key feature of a resilient system (Walker et al., 2004; Chuvarajan et al., 2006; Folke et al., 2006). However, according to numerous scholars, self-organization has been here intended as an inherent characteristic of complex systems, such as the urban systems. It "can be defined", indeed, "as the spontaneous emergence of global structure out of local interactions. Spontaneous means that no internal or external agent is in control of the process (…). This makes the resulting organization intrinsically robust and resistant to damage and perturbations" (Heylighen, 2008). According to such interpretation, self-organization has not been included among the selected characteristics. Nevertheless, self-organizing mechanisms that will arise as a consequence of the internal and external changes of the systems should be adequately understood and monitored.

Then, to better understand how these characteristics act and interact for improving the response capacities of complex urban systems in the face of climate change, a further step is required. Climate change is indeed a challenging threat that requires long term as well as short-medium term strategies. Thus, on the one hand, long-term strategies capable to reduce GHG emissions and energy consumptions, by promoting cities' transition from current energy consuming development patterns towards low-carbon patterns, are required; on the other hand, short-medium term adaptation strategies, aimed at reducing the vulnerability of urban systems to the heterogeneous impacts of climate-related phenomena, ranging from sudden (e.g. flash floods, heat waves, etc.) to slow (e.g. droughts) phenomena and to improve cities capacities to better cope with more and more "beyond the expected" or even "unexpected" phenomena, have to be developed.

Characteristic	Concept	Definition
Connectivity	Resilient City	It is related to "the density of the links within the network, i.e., the number of links divided by the maximum possible number of links" and to the "reachability, or the extent to which all the nodes in the network are accessible to each other" (Janssen et al., 2006)
Knowledge	Resilient City	The capacity to elaborate knowledge and learn from management mistakes, protecting a system from the failure due to subsequent management actions based on incomplete knowledge and understanding (Berkes, 2004)
Memory	Resilient City	"The ability of a system to preserve knowledge and information" (Folke et al., 2005)
Modularity	Resilient City	"It is the degree to which a system's components may be separated and recombined" (Elmqvist, 2013)
Persistence	Resilient City	System's ability to withstand an impact, preserving its own characteristics and structure, except for a temporary departure from the ordinary functioning conditions (Folke et al., 2010)
Redundancy	Resilient City	Spare or superfluous "elements, systems, or other units (..) capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality" (Bruneau et al., 2003; Walker and Salt, 2006; Schultz et al., 2012; Tyler & Moench, 2012).
Resistance	Resilient City	The degree to which systems are displaced (or disturbed) by a given physical force or pressure (Carpenter et al., 2001)
Resourcefulness	Resilient City	"The capacity to (…) mobilize resources when conditions exist that threaten to disrupt some element, system, or other unit of analysis" including "the ability to apply material and human resources to meet established priorities and achieve goals" (Bruneau et al., 2003)
Robustness	Resilient City	The "ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function" (Bruneau et al., 2003).
Transformability	Resilient City	"Capacity of people to create a fundamentally new social-ecological system when ecological, political, social or economic conditions make the existing system untenable" (Walker et al., 2004)
Anticipation	Smart City	Capacity to conceive future predictable scenarios. Indeed, a smart city can provide "tools to exploit various sources of information about human behavior to aid in the allocation of resources—land, water, transportation, and so on—as the city evolves" (Naphade et al., 2011)
Monitoring	Smart City	"The capacity to monitor all critical infrastructures is crucial for a smart city in order to better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens" (Hall, 2000)
Reliability	Smart City	Degree to which a measure repeatedly and consistently produces the same result (BSI, 2014)

Tab. 4 The most important characteristics of Smart City and Resilient City

It is worth stressing that, in respect to the different time spans (short-medium-long term) that characterize the response of a complex urban system in the face of climate change, the selected characteristics play different roles. Therefore, in order to highlight their roles and linkages in the different phases, the selected characteristics have been framed into a conceptual model (Fig. 7).

So far numerous and heterogeneous models on Smart and Resilient City have been developed; these models can be distinguished at least into three different categories:

- "theoretical" models that, based on scientific theories, are addressed to understand and represent cities' dynamics and development;
- "operational" models, which provide a vision for urban development and outline a path for achieving it;
- "hybrid" models, combining a solid theoretical background with some operational elements.

The Smart City literature is largely focused on "operational" models, defining intervention sectors for projects implementation (Lekamge and Marasinghe, 2013), despite the lack of a "solid theoretical framework for smart cities" (Harrison et al., 2011).

In the Resilient City literature, some "theoretical" models, addressed to investigate the main characteristics of a resilient city (Tyler and Moench, 2012; Davoudi, 2013; Galderisi, 2013), as well as some "operational" models aimed at supporting municipalities in developing strategies for disaster risk reduction (Mehrotra et al., 2009; Prasad et al., 2010) or for climate adaptation (e.g., Climate-Adapt Platform, 2014) have been carried out. Unfortunately, most of the two groups of models seem to travel separately, in that the operational models do not mirror the hints provided by the theoretical ones; only recently some "hybrid" models, based on a robust theoretical framework and providing some operational tools for improving urban resilience, have been developed (Tyler et al., 2014).

Hence, the conceptual model for building up smart and resilient cities in the face of climate related challenges represents one of the first attempts to develop an "hybrid" model, framing smart and resilient cities' characteristics along the different temporal stages that characterize the response of a complex urban system in the face of climate change (fig.7).

The model is structured as a cyclical process, based on the learning capacity of urban systems and characterized by the "dynamic interplay of persistence, adaptability and transformability" (Folke et al., 2010). The capacity of "continual learning" is considered as crucial both for the Smart and the Resilient City concept (Cutter et al., 2008; Sinkiene, 2014). According to Davoudi et al. (2013), it allows urban systems to resist "disturbances (being persistent and robust)", to absorb "disturbances (…) (being flexible and adaptable)" and to move "towards a more desirable trajectory (being innovative and transformative)". Hence, it may allow urban systems to improve their capacity both to "bounce-back" in the face of climate-related impacts or to "bounce forward", including the idea of anticipation and improvement of their essential structures and functions through long-term strategies (IPCC, 2012). Moreover, the most recent approaches to the resilience concept provide an interpretation of the latter as the "dynamic interplay of persistence, adaptability and transformability across multiple scales" (Folke et al., 2010): such a dynamic interplay allows a resilient system to extend its focus beyond resistance to shocks, including adaptive responses as well as long-term transformation in the face of future or unforeseen threats (Galderisi, 2014).

Therefore, learning capacity, persistence, adaptability and transformability have been classified as the key properties of a smart and resilient city or, better, as the main goals to which strategies and measures have to be addressed for improving cities' response in the face of climate change. The cyclical structure of the process is characterized by three different stages (strategies' definition, implementation and management) developing over time and connected through a feedback loop: such a structure emphasizes that a smart and resilient urban system does not represent a "fixed state" (Davoudi, 2012), but it results from a dynamic and continuous process. Learning capacity is at the base of the process and allows the system to start, revise or change the strategies addressed to achieve the key properties of a smart and resilient city. Despite the dynamic interplay of these characteristics over time and across space, it is worth noting that each of them gains relevance in a different time span: in the short term, strategies are generally addressed to improve cities' capacities to withstand the expected (or the most likely) climate-related impacts, by increasing system's persistence; in the medium term, strategies are addressed to enhance cities' capacity to cope with unexpected impacts, by improving system's adaptability; then, long term strategies, by improving cities' transformability, should drive urban transition towards novel development pattern, capable to reduce energy footprint of cities and, in so doing, to prevent future climate-related impacts.

Within the model, all the selected characteristics, according to their meanings and relevance, have been hierarchized and related to one or more of the identified key properties, which are the learning capacity, the persistence, the adaptability and the transformability. Such key properties can be improved by other subordinate characteristics that can be related to more than one key properties, such as the efficiency that is common to the persistence and the adaptability. In detail, learning capacity can be improved through strategies and actions addressed to enhance: networking capacity that allows to connect people and devices for exchanging data and information; monitoring capacity, which allows to constantly detect the conditions of an urban system; knowledge that allows to elaborate information about events and processes; memory, which allows to learn from past events in order to figure out possible future scenarios; collaboration, which favors interactions and synergies between different stakeholders; participation, which allows to involve people in the decision-making processes. Moreover, learning capacity is intended crucial for developing people and institutions' awareness about climate-related issues, to improve the capacity to anticipate likely future events, which can threaten urban systems, and, mainly grounding on monitoring and knowledge, to guarantee an effective management of the urban system along the time.

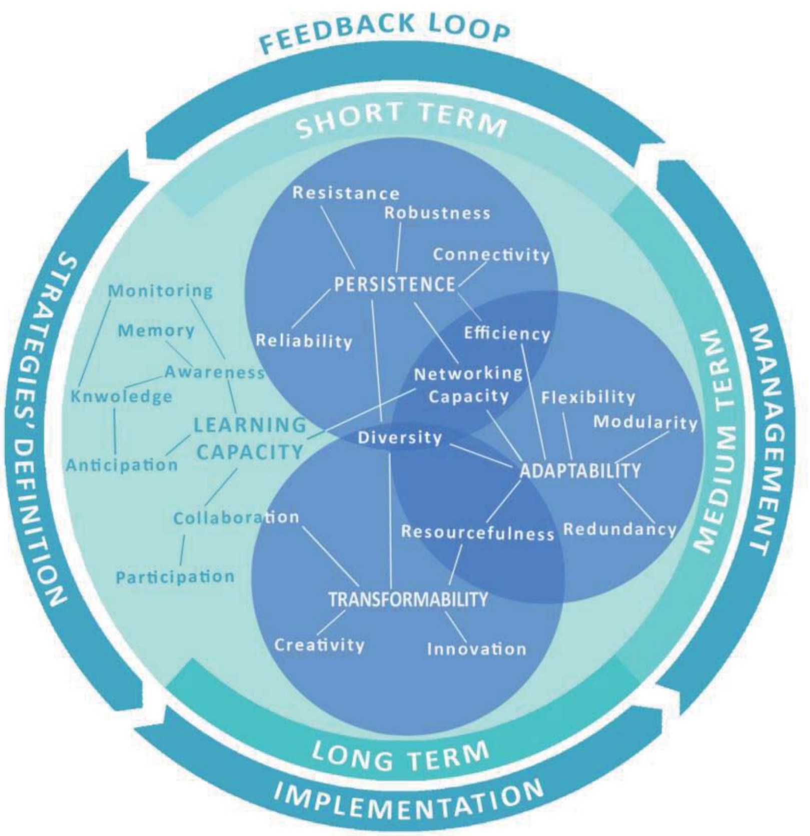


Fig. 7 The conceptual model: roles of and linkages among the capacities of a Smart and Resilient Urban System in the face of climate change.

Finally, as emphasized above, learning capacity provides inputs for enhancing persistence, adaptability and transformation of the system in the face of climate change: these properties, which come to the fore in different temporal stages, provide in turn information that, being continuously processed, can be used as an input to further increase the learning capacity (feedback loop).

Persistence, generally referred to the ability of an urban system to maintain the characteristics and structures in the face of a threatening factor, can be improved through strategies and actions addressed to enhance: robustness, which is the ability of elements and systems to withstand a given impact without suffering degradation or loss of function (Bruneau et al., 2003); resistance that allows the urban system to not be displaced (or disturbed) by a given pressure (Carpenter et al., 2001); reliability, which is the certainty of a result (BSI, 2014); efficiency, that is the capacity to optimize the performance with modest resource consumptions (Fiksel, 2003; Aoun, 2013; Kramers et al., 2014); diversity, related to the plurality of functions and of knowledge (Berkes et al., 2002); connectivity, related to the density of links within a network and to the extent to which all the nodes of the network are accessible to each other (Janssen et al., 2006); networking capacity, which refers to the ability to create networks of non-identical elements or actors, connected by diverse interactions or links (Chuvarayan et al., 2006).

In an integrated smart and resilient system, the networking capacity regards also the capacity to connect computers and devices, since the information exchange increases the urban system persistence, supporting for example the real time mobilization of resources and services where they are needed.

The networking capacity is crucial also for the adaptability because it allows the creation of diverse network configurations.

Adaptability, generally related to the capacity of an urban system to adapt itself to unforeseen situations (Ratti and Townsend, 2011), can be improved through strategies and actions addressed to enhance: flexibility that, in opposition to hierarchical organizations, allows a system to be changed or adjusted to meet particular or changing needs; diversity that, recognized as crucial in case of impacts of adverse events, allows a system to better cope with uncertainty and surprise; a diverse economy ensures, for example that there is overall economic viability if one economic activity fails (Berkes et al. 2002); resourcefulness that refers to the availability of ecological, economic, social and cultural capital, allows the system to better cope with external pressures; modularity, which allows to recombine the elements of a system, supporting the transition towards different configurations; redundancy, which allows the system to count on superfluous/substitutable elements for adapting adaptable in the face of pressures; efficiency, that allows to reach optimal performances in the adapted configuration.

Finally, transformability that represents the capacity to create a fundamentally new system when ecological, political, social or economic conditions make the existing one untenable (Walker et al., 2004), can be improved through strategies and actions addressed to enhance: innovation in all elements and sectors of urban systems, from the physical to immaterial aspects, comprising the introduction of new methods, ideas, products or processes to achieve desirable outcomes (BSI, 2014); creativity, which generally results from research and experimentation that provide spurs for innovating cities in face of complex and unpredictable events; collaboration that allows to exchange new information and inputs and fosters creativity; resourcefulness, which refers to the ability to mobilize and use the available resources supporting the transition of the system towards new configurations; diversity, that allows elements to be separated and connected in new configurations.

As mentioned above, so far very few studies have attempted to combine a robust theoretical framework with operational tools.

The conceptual model - framing smart and resilient cities' characteristics along the different temporal stages that characterize the dynamic process for improving cities' capacity to deal with climate change and its impacts - provides a robust theoretical background for building up smart and resilient cities in the face of climate change.

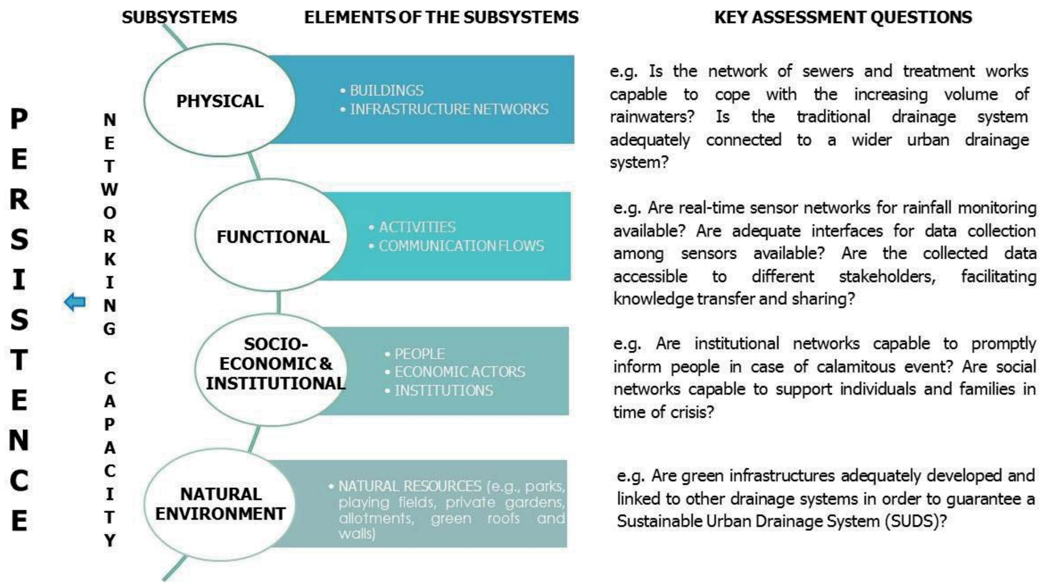


Fig. 8 Towards a guiding tool for evaluating the characteristics of a Smart and Resilient Urban System: an example related to the "networking capacity".

Nevertheless, an effective tool capable to guide planners and decision-makers in carrying out long, medium and short-term strategies addressed to pursue the key properties of a smart and resilient urban system in the face of climate change is still far to be achieved.

To bridge this gap, the next phase of the research work will be addressed to further develop the methodological path for guiding planners and decision makers in the assessment – with reference to the heterogeneous climate drivers and in respect to the different subsystems which constitute an urban system, physical, functional, socio-economic and institutional, natural environment (Papa et al., 2009) – of the different selected characteristics as well as in finding out the most appropriate strategies for enhancing them and monitoring their effectiveness.

An example may clarify what is meant here. According to the conceptual model, the persistence of the urban system in the face of intense rainfalls can be enhanced, by acting on different characteristics (robustness, reliability, connectivity, networking capacity, etc.). Hence, in the figure 8, an example of the methodological path for guiding planners and decision makers through the evaluation of the networking capacity of the different subsystems of an urban system, by using key assessment questions has been provided.

6 CONCLUSIONS

This study represents a first step of a wider research work addressed to develop conceptual and operational tools for improving cities' response in the face of the heterogeneous challenges posed by the climate-related phenomena. In detail, this contribution focuses on the metaphors of "smart" and "resilient" cities that, according to current scientific literature, seem to play a leading role in enhancing cities' capacities to cope with climate change. Based on the in-depth analysis of the current scientific literature in the field of both Smart City and Resilient City, this study has been firstly addressed to identify the main characteristics of a smart and resilient urban system. It has to be underlined that while in the resilience research field a large set of studies and researches have been focused on the characteristics of a resilient system, the Smart City literature does not provide in-depth studies on the characteristics of a smart urban system. However, some useful hints in this direction arise from the studies carried out by companies involved in the development of the Smart City standards (e.g., BIS, 2014) and from research works addressed to investigate Smart City performances (e.g., Coe, 2001; Giffinger et al., 2007; Lekamge and Marasinghe, 2013).

Then, the collected characteristics have been selected and framed into a conceptual model aimed at supporting the development of multi-objective strategies capable to improve the response capacities of complex urban systems in the face of climate change. The model is structured as a cyclical process, based on the learning capacity of urban systems and characterized by the "dynamic interplay of persistence, adaptability and transformability" (Folke et al., 2010); it outlines the temporal and operational phases that characterize the response of a complex urban system in the face of climate change, underlining roles and linkages of the different characteristics along this process, according to the different time spans (short-medium-long term). In detail, the model highlights that some characteristics (transformability) are crucial for supporting long-term strategies capable to reverse current urban development patterns in order to reduce GHG emissions and energy consumptions; others (persistence/adaptability) are relevant to short-medium term strategies aimed at enhancing cities' capacities to withstand or adapt to the heterogeneous climate-related impacts; others (such as learning) are at the base of the process, allowing the system to start, revise or change the strategies addressed to achieve the key properties of a smart and resilient city.

Although the conceptual model provides planners and decision-makers with a robust theoretical background for building up smart and resilient cities, it represents only a preliminary step for the development of an operational tool capable to guide them in carrying out multi-objective strategies addressed to enhance the response capacities of complex urban systems in the face of climate change.

To bridge this gap, the next step of this research work will be addressed to further develop the methodological path for guiding planners and decision-makers in evaluating – with reference to the heterogeneous climate drivers and in respect to the different subsystems which constitute an urban system – the characteristics of a smart and resilient urban system, as well as in finding out adequate strategies for enhancing them and monitoring their effectiveness.

ACKNOWLEDGEMENTS

The paper is part of a wider research work developed in the framework of the "SEM Project - Smart Energy Master for the energy management of territory", which aims at developing methods and tools for improving energy efficiency within high-density urban areas, as well as for dealing with climate change impacts and energy resources' scarcity, through an integrated strategy capable of improving smartness and resilience of urban areas.

REFERENCES

ABB (2012). Solid Foundations for Smart Cities. White paper. Available at:http://new.abb.com/docs/default-source/smart-grids-library/abb_smart_grids_white_paper_2013.pdf?sfvrsn=2.

ABB-Ambrosetti (2012). Smart Cities in Italia: un'opportunità nello spirito del Rinascimento per una nuova qualità della vita. Available at: http://www02.abb.com/db/db0003/db002698.nsf/0/0ea1c1498ed742dec1257a700032fbc8/$file/REPORT_ABBAmbrosetti_Completo.pdf.

ACCCRN (2012). ACCCRN City Projects Catalogue. Available at: http://www.acccrn.org/resources/documents-and-tools/2012/08/01/acccrn-city-projects-catalogue.

ACCCRN (2015). Resilience – an important aspect of Smart Cities. Available at: http://www.acccrn.org/news-and-events/entries/2015/01/06/resilience-%E2%80%93-important-aspect-smart-cities.

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, F. C., Rockström J. (2005). Social-Ecological Resilience to Coastal Disasters. Science 12 August 2005. Vol. 309 no. 5737 pp. 1036-1039. DOI: 10.1126/science.1112122.

Ahern, J. (2011). From fail-safe to safe-to-fail: sustainability and resilience in the new urban world. Landscape and Urban Planning, 100, 341-343

Alberti M., Marzluff J. M., Shulenberger E., Bradley G., Ryan C., Zumbrunnen C. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. BioScience 53:1169-1179.

Alexander, D.E. (2013), Resilience and disaster risk reduction: an etymological journey, Natural Hazards and Earth System Science, 13, 2707–2716. www.nat-hazards-earth-syst-sci.net/13/2707/2013/ doi:10.5194/nhess-13-2707-2013

Aoun, C. (2013). The Smart City Cornerstone: Urban Efficiency. Schneider Electric White Paper. Available at: http://www.digital21.gov.hk/sc/relatedDoc/download/2013/079%20SchneiderElectric%20%28Annex%29.pdf.

Auge Blùm, I., Boussetta, K., Rivano, H., Stanica, R., Valois, F. (2012). Capillary Networks: A Novel Networking Paradigm for Urban Environments. Proceedings of UrbaNE'12, December 10, 2012, Nice, France. Available at: http://conferences.sigcomm.org/co-next/2012/eproceedings/urbane/p25.pdf.

Bahadur, A. V., Ibrahim, M., Tanner, T. (2010). The resilience renaissance? Unpacking of resilience for tackling climate change and disasters. Strengthening Climate Resilience Discussion. Paper 1, Brighton: IDS. Available at: http://community.eldis.org/.59e0d267/resilience-renaissance.pdf.

Bankoff, G., Frerks, G., Hilhorst, D. (2004). Mapping vulnerability. Disasters, development and people. Earthscan, London.

Batty, M. (2008). Cities as Complex Systems. Scaling, Interactions, Networks, Dynamics and Urban Morphologies. Working Papers Series, Paper 131, Centre for Advanced Spatial Analysis, University College London, ISSN 1467-1298. http://discovery.ucl. ac.uk/15183/1/15183.pdf

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G., Portugali, Y. (2012). Smart City of the Future. The European Physical Journal - Special Topics 214, 481–518.

Bencardino, M., Greco, I. (2014). Smart Communities. Social Innovation at the Service of the Smart Cities. *TeMa, Journal of Land Use, Mobility and Environment*. Special Issue.

Berkes, F., Colding, J., Folke, C. (2003). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge.

Birkmann, J., Garschagen, M., Kraas, F. (2010). Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change. Sustainable Science 5(2):185-206. http://ihdp.unu.edu/file/get/10637.pdf.

Brand, F.S., Jax, K. (2007). Focusing the Meaning(s) of Resilience: Resilience as a Descriptive Concept and a Boundary Object. Ecology and Society 12(1): 23.

BSI (2013). Smart Cities: background paper. British Standards Institution. ISBN: 978 0 580 81874 5. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/246019/bis-13-1209-smart-cities-background-paper-digital.pdf.

BSI (2014). PAS 180, Smart cities – Vocabulary. British Standards Institution.

Brundtland Report (1987). Our common future. World Commission on Environment and Development (WCED). Oxford: Oxford University Press, 1987 p. 43.

Bruneau, M., Chang, S.E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, K., Wallace, W. A., von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. Earthquake Spectra, 19(4), 733–752.

Caragliu, A., Nijkamp, P. (2008). The impact of regional absorptive capacity on spatial knowledge spillovers. Tinbergen Institute Discussion Papers 08-119/3, Amsterdam: Tinbergen Institute.

Caragliu, A., Del Bo, C., Nijkamp, P. (2009). Smart cities in Europe. Proceedings of the 3rd Central European Conference in Regional Science (Košice, Slovak Republic, Oct 7-9). Available at: http://www.cers.tuke.sk/cers2009/PDF/01_03_Nijkamp.pdf.

Carpenter, S.R., Walker, B.H., Anderies, J.M. and Abel, N. (2001), From metaphor to measurement. Resilience of what to what? Ecosystems 4: 765-781.

Chelleri, L., Kunath, A., Minucci, G., Olazabal, M., Waters, J. J., Yumalogava, L. (2012). Multidisciplinary perspective on urban resilience. Workshop report. BC3, Basque Centre for Climate Change. ISBN: 978-84-695-6025-9. Available at: http://www.bc3research.org/multidisciplinary_perspectives_on_urban_resilience.

Chen, J., Chen, T. H. Y., Vertinsky, I., Yumagulova, L. and Park, C. (2013). Public–Private Partnerships for the Development of Disaster Resilient Communities. Journal of Contingencies and Crisis Management, 21: 130–143. doi: 10.1111/1468-5973.12021.

Chourabi, H., Taewoo Nam, Walker S., Gil-Garcia J.R. ; Mellouli S., Nahon K., Pardo, T.A., Scholl H. J. (2012). Understanding Smart Cities: An Integrative Framework. 45th Hawaii International Conference on System Sciences. 978-0-7695-4525-7/12 $26.00 © 2012 IEEE. DOI 10.1109/HICSS.2012.615.

Chuvarajan A., Martel I., Peterson C. (2006). A Strategic Approach for sustainability and resilience planning within municipalities. Thesis submitted for completion of Master of Strategic Leadership towards Sustainability, Blekinge Institute of Technology, Karlskrona, Sweden.

CIAT (2015). Report for Cities Impacts & Adaptation Tool. Climate Center, University of Michigan. Available at: http://graham-maps.miserver.it.umich.edu/ciat/report.xhtml.

Coe A., Paquet G., Roy J. (2001). E-Governance and Smart Communities: A Social Learning Challenge. Social Science Computer Review 2001; 19; 80.

Cohen, B. (2012). The top 10 smartest European cities. Available at: http://smartertrends.co.uk/articles/2012-11-14/the-top-10-smartesteuropeancities/original/?original=www.fastcoexist.com/1680856/the-top-10-smartest-european-cities

Colucci A. (2012). Le città resilienti: approcci e strategie. Monografia, Jean Monnet Centre of Pavia. Available at: http://www.jeanmonnet-pv.it/Jean_Monnet_Centre_of_Excellence/publications_files/full_txt_colucci_jm.pdf.

Cretu L. G. (2012). Smart Cities Design using Event-driven Paradigm and Semantic Web. Informatica Economică vol. 16, no. 4/2012. Available at: http://www.revistaie.ase.ro/content/64/07%20-%20Cretu.pdf.

Cutter S.L., Barnes L., Berry M., Burton C., Evans E., Tate E., Webb J. (2008), "A place-based model for understanding community resilience to natural disasters", Global Environmental Change, 18:598-606.

Dameri R. P. (2013). Searching for Smart City definition: a comprehensive proposal, International Journal of Computers & Technology. Vol 11, No.5. October 25, 2013. PP. 2544-2551.

Davoudi S. (2012). Resilience: A Bridging Concept or a Dead End?. Planning Theory and Practice 2012, 13(2), 299-307.

Davoudi S., Brooks E., Mehmood A. (2013), "Evolutionary Resilience and Strategies for Climate Adaptation", Planning Practice & Research, 28:3, 307-322. http://dx.doi.org/10. 1080/02697459.2013.787695

Da Silva J., Kernaghan S., Luque A. (2012). A systems approach to meeting the challenges of urban climate change. International Journal of Urban Sustainable Development, 4(2), 125–145.

Deakin M. (2012). Smart Cities: Governing, Modelling and Analysing the Transition. Routledge, 2012.

Dirks S., Gurdgiev C., Keeling, M. (2010). Smarter cities for smarter growth. How cities can optimize their systems for the talent-based economy. IBM Global Business Services. Executive Report.

Drobniak A. (2010). The Urban Resilience – Economic Perspective. Journal of Economics & Management. Vol. 10/2012. University od Economics in Katowice.

EEA (2012). Urban adaptation to climate change in Europe - Challenges and opportunities for cities together with supportive national and European policies. EEA Report No 2/2012. ISBN: 978-92-9213-308-5. Available at: http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change.

EEA (2014). Report of the EEA Scientific Committee Seminar on Environment, Human Health and Well-Being. Advancing the Knowledge Base. Summary of discussion at the European Environment Agency's Scientific Committee Seminar on 12 February 2014 in Copenhagen. Available at: http://www.eea.europa.eu/about-us/governance/scientificcommittee/reports/report-of-the-eea-scientific.

Eger J. M. (2009). Smart Growth, Smart Cities, and the Crisis at the Pump A Worldwide Phenomenon. I-WAYS - The Journal of E-Government Policy and Regulation. Volume 32 Issue 1, January 2009. Pages 47-53.

EIP - European Innovation Partnership on Smart Cities and Communities (2013). Available at: http://ec.europa.eu/energy/technology/initiatives/doc/2012_4701_smart_cities_en.pdf.

EIP - European Innovation Partnership on Smart Cities and Communities (2014). Available at: http://eu-smartcities.eu/content/show-world-you-are-smart-city.

Elmqvist, T. (2013). How Smart is a Smart City? Presentation at the Switched on Nature Seminar. Available at: http://www.stockholmresilience.org/5.2f48c3c31429b6ad0a61192.html.

ENSURE (2012). Integration of different vulnerabilities vs. Natural and Natech Hazards. Deliverable 2.2 of the Enhancing resilience of communities and territories facing natural and na-tech hazards Project.

Ercoskun, O.Y. (2012). A Paradigm Shift towards Urban Resilience. Green and Ecological Technologies for Urban Planning: Creating Smart Cities. IGI Global, 2012. 1-16. Web. 19 Jan. 2015. doi:10.4018/978-1-61350-453-6.ch001.

Ernstson, H., van der Leeuw, S., Redman, C.L., Meffert, D.J., Davis, G., Alfsen, C., Elmqvist, T. (2010). Urban transitions: on urban resilience and human-dominated ecosystems. AMBIO: A Journal of the Human Environment, pages 1–15.

EU (2009). Adapting to climate change: Towards a European framework for action. White Paper. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0147&from=EN.

EU (2011). Cities of tomorrow. Challenges, visions, ways forward. European Union, 2011. ISBN: 978-92-79-21307-6. doi:10.2776/41803. Available at: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/citiesoftomorrow/citiesoftomorrow_final.pdf.

EU (2013). An EU Strategy on adaptation to climate change. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0216&from=EN.

EU LIFE (2014). Urban Resilience - LIFE+ projects and European policies. 4-5 April 2014, Colombes, FR. Summary Report. Available at: http://ec.europa.eu/environment/life/news/newsarchive2014/documents/report-urbanresilience.pdf.

Fiksel, J. (2003). Designing resilient, sustainable systems. Environmental Science & Technology, 37(23), 5330–5339

Florida, R. (2003). Cities and the Creative Class. City and Communities. Volume 2, Issue 1, pages 3–19.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson L., Holling C.S., Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Ambio Vol. 31 No. 5.

Folke, C., Hahn, T., Olsson, P., Norberg, J. (2005). Adaptive Governance for Social-Ecological System. Annu. Rev. Environ. Resour. 30:441-73

Folke, C. (2006). Resilience: The Emergence of a Perspective for Social-Ecological Systems Analyses, in Global Environmental Change 16: 253–67.

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., Rockstrom, J. (2010) "Resilience Thinking: integrating Resilience, Adaptability and Transformability", Ecology and Society, 15(4):20. http://www.ecologyandsociety.org/vol15/iss4/art20/

Fusco Girard, L., Baycan, T., Nijkamp, P. (2012). The Creative City in a Multidimensional Perspective. Chapter of "Sustainable City and Creativity: Promoting Creative Urban Initiatives". Ashgate Publishing, Ltd.

Füssel, H.-M., Klein, R. J. T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. Climatic Change, 75(3), 301–329

Galderisi, A., Ferrara, F.F. (2012). Enhancing Urban Resilience In Face Of Climate Change, *TeMa, Journal of Land Use, Mobility and Environment*. Vol. 2, 69-87. DOI: 10.6092/1970-9870/936

Galderisi, A. (2013). Un modello interpretativo della resilienza urbana. PLANUM, the Journal of Urbanism. ISSN 1723-0993 | no. 27, vol. II [2013].

Galderisi, A. (2014). Climate Change Adaptation. Challenges and Opportunities for a Smart Urban Growth. *TeMa, Journal of Land Use, Mobility and Environm*ent. Vol.7, n.1.

Gibson, D.V., Kozmetsky, G., Smilor, R.W. (eds.) (1992), The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks, Rowman & Littlefield, New York.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., Meijers, E. (2007). Smart Cities: Ranking of European Medium-Sized Cities. Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology. Available at: http://www.smartcities.eu/download/smart_cities_final_report.pdf.

Glaeser, E.L., Berry, C.R. (2006). Why Are Smart Places Getting Smarter?. Taubman Cente Policy Brief 2006-2, Cambridge MA: Taubman Centre.

Godschalk, D.R. (2003). Urban Hazard Mitigation: Creating Resilient Cities. Natural Hazards Review, ASCE, August. DOI: 10.1061/~ASCE!1527-6988~2003!4:3~136!

Gunderson, L. (2010). Ecological and human community resilience in response to natural disasters. Ecology and Society 15(2): 18.

Hall, R. E. (2000). The vision of a smart city. In Proceedings of the 2nd International Life Extension Technology Workshop, Paris, France, September 28.

Hallegatte, S. (2009). Strategies to adapt to an uncertain climate change. Global Environmental Change 19 (2009) 240–247.

Heeks, R., Ospina, A. V. (2013). Understanding Urban Climate Change and Digital Infrastructure Interventions from a Resilience Perspective. Centre for Development Informatics. ISBN: 978-1-905469-77-2.

Heylighen, F. (2008), Complexity and Self-organization, in Bates M.J. and Maack N., eds., Encyclopedia of Library and Information Sciences, Taylor & Francis.

Hollands, R. G. (2008). Will the real smart city please stand up?. City: analysis of urban trends, culture, theory, policy, action. Volume 12, Issue 3, 2008. DOI: 10.1080/13604810802479126

Holling, C.S. (1973). Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4:1–23.

Holling, C.S. (1996), Engineering resilience versus Ecological resilience, in P. Schulze (ed.), Engineering with ecological constrains, National Academy, Washington, D.C., USA.

Hopkins, R. (2008). The transition handbook: from oil dependency to local resilience. Green Books, Totnes, Devon, UK. ISBN: 9781900322188

ICLEI (2014a). Available at: http://resilient-cities.iclei.org/resilient-cities-hub-site/resilience-resource-point/glossary-of-key-terms/.

ICLEI (2014b). How does the Urban NEXUS Approach and inter-sectoral coordination make cities more resilient? A.3. SESSION DESCRIPTION – 5TH Global Forum on Urban Resilience & Adaptation. Bonn, Germany 29-31 May 2014.

IFRC - International Federation of Red Cross and Red Crescent Society (2011). Characteristics of a Safe and Resilient Community. Community Based Disaster Risk Reduction Study. Available at: http://www.ifrc.org/ PageFiles/96986/Final_Characteristics_Report.pdf.

IPCC (2012), Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Cambridge University Press, Cambridge, UK, New York, USA. http://ipcc-wg2.gov/SREX/images /uploads/SREX-All_FINAL.pdf

IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. Available at: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

IPCC (2014). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

ISO/IEC (2014). Smart Cities. Preliminary Report 2014. ISO/IEC JTC 1, Information technology. Available at: http://www.iso.org/iso/smart_cities_report-jtc1.pdf.

ITU (2014). United Nations specialized agency for information and communication technologies – Focus Group on Smart Sustainable Cities. Available at: http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx.

Jabareen, Y. (2013). Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. Cities 31 (2013) 220–229.

Janssen, M. A., Bodin, Ö., Anderies, J. M., Elmqvist, T., Ernstson, H., McAllister, R. R. J., Olsson, P., Ryan, P. (2006). Toward a network perspective on the resilience of social-ecological systems. Ecology and Society 11(1): 15.

Jerneck, A., Olsson, L. (2008). Adaptation and the Poor: Development, Resilience and Transition. Climate Policy, 8(2): 170–82.

Kahan, J. H., Allen A. C., George, J. K. (2009). An operation framework for resilience. Journal of Homeland Security and Emergency Management. Volume 6, Issue 1. 2009. Article 83.

Kallaos J., Mainguy G., Wyckmans A. (2014). Considering Resilience: steps towards an assessment framework. *TeMa, Journal of Land Use, Mobility and Environment*. Vol.5, n.27.

Karnouskos S., Da Silva P. G., Ilic D. (2013). Energy Services for the Smart Grid City. Digital Ecosystems Technologies (DEST), 6th IEEE International Conference.

Klein R.J.T., Nicholls R.J., Thomalla F. (2003). Resilience to natural hazards: How useful is this concept? Global Environmental Change Part B: Environmental Hazards. Volume 5, Issues 1–2, 2003, Pages 35–45.

Klein, R.J.T., Schipper, E. L., Dessai, S. (2005). Integrating mitigation and adaptation into climate and development policy: three research questions. Environmental Science & Policy 8: 579–588. Available at: http://www.unisdr.org/files/1140_sdarticle.pdf.

Kramers A., Höjer M., Lövehagen N., Wangel J. (2014). Smart sustainable cities e Exploring ICT solutions for reduced energy use in cities. Environmental Modelling & Software.

Kuhn T.S. (1970). The Structure of Scientific Revolutions. International Encyclopedia of Unified Science, Foundations of the Unity of Science, Volume II, Number 2. Available at: http://projektintegracija.pravo.hr/_download/repository/Kuhn_Structure_of_Scientific_Revolutions.pdf.

Kunzmann K.R (2014). Smart Cities: A New Paradigm of Urban Development. Crios, 1/2014, pp. 9-20, doi: 10.7373/77140.

Lazaroiu G. C., Roscia M. (2012). Definition methodology for the smart cities model. Energy 47 (2012) 326-332. doi:10.1016/j.energy.2012.09.028.

Lee J.H., Phaal R., Lee S. H. (2013). An integrated service-device-technology roadmap for smart city development. Technological Forecasting and Social Change 80, 286–306. doi:10.1016/j.techfore.2012.09.020.

Lekamge S., Marasinghe A. (2013). Developing a Smart City Model that Ensures the Optimum Utilization of Existing Resources in Cities of All Sizes. Biometrics and Kansei Engineering (ICBAKE), 2013 International Conference, pp.202-207, 5-7 July 2013. doi: 10.1109/ICBAKE.2013.40.

Lombardi P. (2011). Managing the green IT agenda. Intelligent Buildings International Vol. 3, Iss. 1.

Longstaff P. H., Armstrong N. J., Keli P., Parker W. M., Hidek M. (2010). Building Resilient Communities - A Preliminary Framework for Assessment. Homeland Security Affairs, VI (3).

Low B., Ostrom E., Simon C., Wilson J. (2000). Redundancy and diversity in governing and managing common-pool resources. 8th Biennial conference of the International Association for the Study of Common Property (IASCP), Indiana University, Bloomington, Indiana, May 31-June 4, 2000.

Maguire B., Hagan P. (2007). Disasters and communities: Understanding social resilience. The Australian Journal of Emergency Management, Vol. 22 No. 2.

Martin-Breen P., Anderies J. M. (2011). Resilience: A Literature Review. Rockefeller Foundation Report. Available at: http://www.rockefellerfoundation.org/blog/resilience-literature-review.

McIntosh R.J., Tainter J. A., McIntosh S. K. (2000). The Way the Wind Blows: Climate, History and Human Action. Columbia University Press.

McMahon K. (2014). Smart Cities and Broadband. Broadband Communities. Available at: http://www.bbcmag.com/2014mags/Nov_Dec/BBC_Nov14_SmartCities.pdf.

Moccia F. D. (2012). Smart city: etimologia del termine. Un'analisi firmata INU. Available at: http://admin.edilio.it/smart-city-etimologia-del-termine-un-analisi-firmata-inu/p_19560.html.

Moir E., Moonen T., Clark G. (2014). What are future cities? Origins, meanings and uses. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/337549/14-820-what-are-future-cities.pdf.

Mosannenzadeh F., Vettorato D. (2014). Defining Smart City: a conceptual framework based on keyword analysis*. TeMa, Journal of Land Use, Mobility and Environment*. Special Issue.

Moser M. A. (2001). What is Smart about the Smart Communities Movement?. EJournal Volume 10-11 Number 1 (March 2001). Available at: http://www.ucalgary.ca/ejournal/archive/v10-11/v10-11n1Moser-print.html#SmartEconomicStrategies.

Moser C., Wendel T., Carabias-Hütter V. (2014). Scientific and Practical Understandings of Smart Cities. Proceedings REAL CORP 2014 Tagungsband 21-23 May 2014, Vienna, Austria.

Naphade M., Banavar G., Harrison C., Paraszczak J., Morris R. (2011). Smarter Cities and Their Innovation Challenges. 0018-9162/11/$26.00 © 2011 IEEE Computer Society.

Nam T., Pardo T. A. (2011). Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. The Proceedings of the 12th Annual International Conference on Digital Government Research. ACM, pp. 282–291.

Navarrete L. C., Dalmas S. ,Varas F. J., Fayos A., Busto F.J. (2012). Social Open Data to harness the empowerment of Smart Community. Available at: http://eu-smartcities.eu/sites/all/files/docs/best-practice/Social%20Open%20DAta%20to%20harness%20the%20empowerment%20of%20Smart%20Community%20.pdf

New City Foundation (2014).Beyond the Smart City: Towards a New Paradigm. Available at: http://www.newcitiesfoundation.org/.

Newman P., Beatley T., Boyer H. (2009). Resilient Cities: Responding to Peak Oil and Climate Change. Island Press, 2009. ISBN: 1597268631.

North P. (2010). Eco-localisation as a progressive response to peak oil and climate change – A sympathetic critique. Geoforum 41 (2010) 585–594.

Norris F., Stevens S., Pfefferbaum B., Wyche K., Pfefferbaum R. (2008), Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness, American Journal of Community Psychology, vol. 41.

Papa R., Battarra R., Calenda C., Cerrone D., Ceudech A., Fistola R., Galderisi A., Gargiulo C., La Rocca R.A., Mazzeo G., Papa E. (2009). Il governo delle trasformazioni urbane e territoriali. Metodi, tecniche e strumenti. Franco Angeli Editore, pp. 560. ISBN: 9788856811476.

Papa R., Galderisi A., Gargiulo C. (2013). Towards an Urban Planners' Perspective on Smart City. *TeMa, Journal of Land Use, Mobility and Environment*. Vol. 6, n.1.

Partridge H. (2004). Developing a Human Perspective to the Digital Divide in the Smart City. In Partridge, Helen (Ed.) Australian Library and Information Association Biennial Conference, 21-24 September 2004, Gold Coast, Queensland, Australia.

Paskaleva K. A. (2009). Enabling the smart city: the progress of city e-governance in Europe. International Journal of Innovation and Regional Development. Volume 1, Number 4/2009. Pages 405-422.

Pellegrini P. (2003). Smart Growth Movement, lo scenario emergente. Tesi di dottorato presentata nel giungno 2003. Pubblicata da Università IUAV di Venezia. IUAV Digital LIbrary © settembre 2011. ISBN 978-88-87697-59-9. Available at: http://rice.iuav.it/270/3/cap_2_smart_growth.pdf.

Pickett S.T.A., Cadenasso M.L., Grove J.M. (2004). Resilient cities: meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms. Landscape and Urban Planning 69 (2004) 369–384.

Pickett S.T.A., Boone C. G., McGrath B. P., Cadenasso M. L., Childers D. L., Ogden L. A., McHale M., Grove J. M. (2013). Ecological science and transformation to the sustainable city, Cities.

Ratti C., Townsend A. (2011). The Social Nexus. Scientific American, September 2011. Available at: http://senseable.mit.edu/papers/pdf/2011_Ratti_Townsend_Nexus_SA.pdf.

Redman C. L. (2014). Should sustainability and resilience be combined or remain distinct pursuits?. Ecology and Society 19(2): 37. http://dx.doi.org/10.5751/ES-06390-190237.

Resilient City (2014). Available at: http://www.resilientcity.org/index.cfm?id=11449.

Rose A. (2007). Economic resilience to natural and man-made disasters: multidisciplinary origins and contextual dimensions. Environmental Hazards, Volume 7, Issue 4, 2007, Pages 383-398, ISSN 1747-7891.

Roeckefeller Foundation (2014). Available at: http://www.rockefellerfoundation.org/our-work/current-work/resilience.

Rockefeller Foundation (2015). Available at: http://www.100resilientcities.org/cities#/-_/.

Rogers C. D. F., Bouch C.J., Williams S., Barber A.R.G., Baker C.J., Bryson J.R., Chapman D.N., Chapman L., Coaffee J., Jefferson, I. and Quinn A.D. (2012). Resistance and Resilience – two paradigms for critical local infrastructure. Proceedings of the ICE - Municipal Engineer, Volume 165, Issue 2, 01 June 2012 ,pages 73 –83.

Sapountzaki K. (2010). Vulnerability management by means of resilience. Natural Hazards: Journal of the International Society for the Prevention and Mitigation of Natural Hazards. ISSN 0921-030X. Nat Hazards. DOI 10.1007/s11069-011-9908-3

Schultz M. T., McKay S. K., Hales L. Z. (2012). The Quantification and Evolution of Resilience in Integrated Coastal Systems (No. ERDC TR-12-7). Washington, DC: U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC).

Simmie J., Martin R. (2010). The economic resilience of regions: towards an evolutionary approach. Cambridge Journal of Regions, Economy and Society 2010, 3, 27–43. doi:10.1093/cjres/rsp029

Smart City Council (2014a). Available at: http://smartcitiescouncil.com/article/next-decade-bring-fourfold-increase-number-smart-cities.

Smart Cities Council (2014b). Smart Cities Readiness Guide. Available at: http://smartcitiescouncil.com/resources/smart-cities-readiness-guide.

Sovacool B. K. (2011). Hard and soft paths for climate change adaptation. Climate Policy 11 (2011) 1177–1183. doi:10.1080/14693062.2011.579315.

Stacey R., Griffin D., Shaw P. (2000). Complexity and management: Fad or Radical Challenge to Systems Thinking? Routledge, London and New York.

STERIA (2011). Smart Cities will be enabled by Smart IT. Available at: http://www.steria.com/fileadmin/com/sharingOurViews/publications/files/STE3899-Smart_Cities_brochure_08_APP.PDF.

Stockholm Resilience Centre (2014). Applying resilience thinking. Seven principles for building resilience in social-ecological systems. Available at: http://www.stockholmresilience.org/21/research/research-news/4-22-2014-applying-resilience-thinking.html.

Suppe F. (1977). Elements of Scientific Theories: Concepts and Definitions, Chapter 2 of “The structure of scientific theories”, second edition.

Tasan-Kok T., van Kempen R., Raco M., Bolt G. (2013). Conceptual Overview of Resilience: history and context. Resilience Thinking in Urban Planning. GeoJournal Library 106. pp. 39-52.

Toppeta D. (2010). The Smart City vision: how innovation and ICT can build smart, “liveable”, sustainable cities. THINK! REPORT 005/2010. Available at: http://www.inta-aivn.org/images/cc/Urbanism/background%20documents/Toppeta_Report_005_2010.pdf.

TURAS (2012). Urban Transformations: Integrating social-ecological resilience thinking into urban planning and governance. Transitioning towards urban resilience and sustainability project. Available at: http://www.turas-cities.org/uploads/biblio/document/file/213/WP3_Lit_Rev_Section_01_.pdf.

Tyler S., Moench S. (2012). A framework for urban climate resilience. Climate and Development. Vol. 4, No. 4, October 2012, 311–326

UN (2014). Population Division World Urbanization Prospects. The 2014 Revision, Highlights. Department of Economic and Social Affairs.

UNEP (2014). Climate Finance for Cities and Buildings - A Handbook for Local Governments. UNEP Division of Technology, Industry and Economics (DTIE), Paris. Available at: www.unep.org/publications.

UNISDR (2012a). Available at: http://www.unisdr.org/campaign/resilientcities/about.

UNISDR (2012b). How to make cities more resilient – A Handbook For Local Government Leaders. Available at: http://www.unisdr.org/we/inform/publications/26462.

Vale, L., Campanella, T.H. (2005). The resilient city: How modern cities recover from disaster. New York: OxFord University Press.

Viitanen, J., Kingston, R. (2014). Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. Environment and Planning A 2014, volume 46, pages 803 – 819. doi:10.1068/a46242

Wagener, W. (2008). Connected and Sustainable ICT Infrastructure. Cisco Internet Business Solutions Group. Report written specifically for Connected Urban Development Global Conference 2008—Amsterdam. Available at: http://www.cisco.com/web/about/ac79/docs/wp/ctd/connected_infra.pdf.

Walker, B., Holling C. S., Carpenter S. R., Kinzig A. (2004). Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5.

Walker B., Salt B. (2006), Resilience thinking: sustaining ecosystems and people in a changing world. Washington, DC: Island Press.

Washburn D., Sindhu U. (2011). Helping CIOs Understand “Smart City” Initiatives. Defining The Smart City, Its Drivers, And The Role Of The CIO. Forrester Research Report. Available at: http://www.itworldcanada.com/archive/Themes/Hubs/Brainstorm/forrester_help_cios_smart_city.pdf.

Wolfram M. (2012). Deconstructing Smart Cities: An Intertextual Reading of Concepts and Practices for Integrated Urban and ICT Development. Proceedings REAL CORP 2012 Tagungsband 14-16 May 2012, Schwechat.

World Bank Group (2011). Guide to Climate Change Adaptation in Cities. Available at: http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1318995974398/GuideClimChangeAdaptCities.pdf.

Zani B. (2012). Empowerment: analisi di un costrutto "intrigante", in: Psicologia di Comunità. Prospettive, Idee, Metodi. ROMA, CAROCCI, 2012, pp. 135 – 162.

IMAGE SOURCES

Cover image: http://pixabay.com/en/rotterdam-erasmus-bridge-stadt-269281/
Fig. 1, 5, 6, 7, 8: figures are from authors
Fig. 2, 3, 4: figures are from Google Trends

AUTHORS' PROFILES

Rocco Papa

Full Professor of Land Use Planning at the University of Naples Federico II. Editor-in-Chief of the Scientific Journal TeMA - Land Use, Mobility and Environment since 2007. Director of the Department of Urban and Regional Planning (DiPiST) of the University Federico II of Naples, from 1999 to 2005. Chairman of the Urban Transformation Company Bagnolifutura S.p.A from 2006 to 2010. Vice-Mayor of the Municipality of Naples, from 2001 to 2006.

City Councilor for Livability (appointed to Town Planning and Historical Centre) for the Naples Municipality, from 1997 to 2001. Research activity, carried out continuously since 1974, has developed according to the following four main lines: the study of the interactions between urban and mobility systems; the management and governance of metropolitan areas; the safeguard of environmental quality in highly urbanized areas; the experimentation of new protocols for urban planning tools connected with the updating of techniques, methods and models of analyses, interpretation, planning and governance of territory. As City Councilor for Livability (appointed to Town Planning and Historical Centre) for the Naples Municipality he has developed in detail the following projects: the approval and implementation of the new Master Plan of Naples; the approval and implementation of the Local Master Plan for the area of Bagnoli-Coroglio and the establishment of the Urban Transformation Company Bagnolifutura SpA, and the restoration and requalification of the "Real Albergo dei Poveri" and of the "SS. Trinità delle Monache", the implementation of the Line 1 and Line 6 of the Metropolitan Railway. He is the author of more than 100 publications.

Adriana Galderisi

Assistant Professor at the Department of Civil, Architectural and Environmental Engineering - University of Naples Federico II. Ph.D. in Urban and Regional Planning; Professor of Urban and Regional Planning at the University of Naples Federico II. Research activities are mainly focused on the urban environment requalification and namely on two issues: the relationships between land use planning, mobility and environmental issues; vulnerability and resilience of urban systems to natural and na-tech events. In respect to the latter, she has coordinated research teams within numerous National and European Projects from 2000 to 2008. From 2008 to 2011, she has been the Scientific Responsible for the European Project "ENSURE - Enhancing resilience of communities and territories facing natural and na-tech hazards" (7° Framework Programme - Theme 6 Environment - Topic 6.1.3.2.1 Frame for better vulnerability assessment). From 2012, she is the Responsible for the Training Project of the National Project "Smart Energy Master for the energy management of territory" (PON 04A2_00120 R&C Axis II). She is author of more than 80 publications (monographs, chapters in books and articles).

Maria Cristina Vigo Majello

Architect (2003), Master in Building and Environmental Design for Photovoltaics Integration (2004), PhD in Architectural Design (2007), PhD in Building and Environmental Recovery (2013) at the Department of Architecture, University of Naples Federico II. She has collaborated in the research activities of the Department of Architecture, University of Naples Federico II, with the Corited Consortium, developing skills on national and international research projects on sustainable energy related to existing built environment (2009-2011). Research activities have been focused on renewable energies, innovative technologies and integrated management models to promote energy efficiency of existing built environment. In 2014, she won a one-year grant for post-lauream education and research within the project "Smart Energy Master" at the Department of Civil Engineering, Building and Environmental Engineering, University of Naples Federico II.

Erika Saretta

Civil Engineer graduated at the University of Padua presenting a dissertation "Photovoltaics and Net Zero Energy Buildings: new concepts towards a Smart City vision", carried out in collaboration with ENEA. In 2014, she won a one-year grant for post-lauream education and research within the project "Smart Energy Master" at the Department of Civil Engineering, Building and Environmental Engineering, University of Naples Federico II.

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 1 (2015) 19-49
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2883

review paper received 20 January 2015, accepted 23 April 2015

www.tema.unina.it

How to cite item in APA format:
Papa, R., Galderisi, A., Vigo Majello M.C., Saretta E. (2015). Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 19-49. doi:http://dx.doi.org/10.6092/1970-9870/2883

SMART AND RESILIENT CITIES

A SYSTEMIC APPROACH FOR DEVELOPING CROSS-SECTORAL STRATEGIES IN THE FACE OF CLIMATE CHANGE

ROCCO PAPA[a], ADRIANA GALDERISI[b],
MARIA CRISTINA VIGO MAJELLO[c], ERIKA SARETTA[d]

[a,b,c,d] Department of Civil, Architectural and Environmental Engineering (DICEA) - University of Naples Federico II
e-mail: [a]rpapa@unina.it, [b]galderis@unina.it,
[c]vigo.majello@unina.it, [d]erika.saretta@unina.it
URL: [a]www.roccopapa.it, [b,c,d]www.dicea.dip.unina.it

ABSTRACT

Climate change is considered one of the main environmental issues challenging contemporary cities. Meanwhile, urban development patterns and the growth of urban population represent the main contributors to climate change, affecting the total energy consumptions and the related greenhouse gas emissions. Therefore, a breakthrough in current urban development patterns is required to counterbalance the climate-related issues.
This study focuses on the Smart City and Resilient City concepts that, according to current scientific literature, seem to play a leading role in enhancing cities' capacities to cope with climate change.
In detail, based on the review of existing literature, this study analyzes the synergies between the two concepts, highlighting how the Smart City concept is more and more widely interpreted as a process addressed to make cities "more livable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Nevertheless, current initiatives to improve cities' smartness and resilience in the European cities are very fragmented and operational tools capable to support multi-objective strategies are still at an early stage.
To fill this gap, embracing a systemic perspective, the main characteristics of a smart and resilient urban system have been identified and framed into a conceptual model. The latter represents a preliminary step for the development of an operational tool capable to guide planners and decision-makers in carrying out multi-objective strategies addressed to enhance the response capacities of complex urban systems in the face of climate change.

KEYWORDS:
smart city, resilient city, systemic approach, climate change, climate adaptation

TeMA 有关土地使用、交通和环境的杂志

TeMA 1 (2015) 19-49
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2883

review paper received 20 January 2015, accepted 23 April 2015

www.tema.unina.it

How to cite item in APA format:
Papa, R., Galderisi, A., Vigo Majello M.C., Saretta E. (2015). Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 19-49. doi:http://dx.doi.org/10.6092/1970-9870/2883

智能与弹性城市

为应对气候变化制定跨部门战略的系统方法

ROCCO PAPA[a], ADRIANA GALDERISI[b],
MARIA CRISTINA VIGO MAJELLO[c], ERIKA SARETTA[d]

[a,b,c,d] Department of Civil, Architectural and Environmental Engineering
(DICEA) - University of Naples Federico II
e-mail: [a]rpapa@unina.it, [b]galderis@unina.it,
[c]vigo.majello@unina.it, [d]erika.saretta@unina.it
URL: [a]www.roccopapa.it, [b,c,d]www.dicea.dip.unina.it

摘要

气候变化被视为对当代城市构成挑战的主要环境问题之一. 同时,城市发展模型与城市人口的增长是气候变化的主要原因, 影响着总能耗与相关的温室气体排放. 因此，为解决气候有关的问题题，需要当前的城市发展模型实现突破.
本研究聚焦于“智能城市”与“弹性城市”的概念;具体而言,本研究以现有文献回顾为基础, 分析了这两个概念之间的协同增效, 强调了智能城市的概念如何越来越广 泛地被诠释成使城市“更宜居、富有弹性, 因此能够更快速地应对新挑战”的过程(Kunzmann，2014). 然而, 当前欧洲各城市提高城市智能与弹性的举措过于碎片化能够支持多目标战略的运营工具尚处于早期阶段为填补这一空缺, 通过采取系统方法 智能弹性城市系统的主要特征已经得到识别并被 整合为一个概念模型. 后者代表了运营工具开发 的初步阶段, 该工具能够指导规划者与决策者落 实多目标战略, 以提高复杂城市系统对于气候变化的响应能力.

关键词
智能城市, 弹性城市, 系统方法,气候变化,
气候适应

1 INTRODUCTION

According to the available trends and projections (UN, 2014), urban population has overcome the rural one since 2005 and it is expected to further increase by 2050. Even though cities represent only the 4% of the Earth's land (UNEP, 2014), they consume about the 67% of the global primary energy (IPCC, 2014) and, due to urban lifestyle and economy, they are responsible for more than the 70% of greenhouse gas (GHG) emissions (Birkmann et al. 2010; EU, 2011) that are, in turn, the main contributors to climate change. Thus, according to current trends, the expected growth of urban population will further increase energy consumptions, worsening the current energy scenario. Moreover, the "continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system" (IPCC, 2013), with effects that will be particularly severe in urban areas, due both to the concentration of people, assets and strategic activities and to the peculiarities of cities that may exacerbate the impacts of the heterogeneous climate-related phenomena.

Fortunately, cities can be interpreted as "cauldrons of diversity and differences and as fonts for creativity and innovation" (Florida, 2003): therefore, although playing a major role in the creation of current environmental challenges, they can be considered as a central part of any response.

Thus, mitigation strategies, addressed to reduce energy consumptions, combined with adaptation strategies, aimed at counterbalancing climate-related impacts, represent crucial challenges that cities have to deal with, in order to guarantee a sustainable urban environment for the rapidly growing urban population. Indeed, on the one hand, mitigation actions can allow the reduction of CO_2 emissions and, consequently, of climate-related impacts on urban areas. On the other hand, adaptation actions can enhance urban capacities to cope with unavoidable impacts of climate change (fig.1).

The issues related to the reduction of energy consumptions and to the urban adaptation to climate change have been considered as crucial in most of the recent metaphors related to urban development and addressed to improve cities capacities to cope with urgent environmental challenges (Moir et al., 2014): eco-cities, low-carbon cities, transition cities, smart cities, resilient cities represent only some examples.

We will focus here on the metaphors of "smart" and "resilient" cities, which seem to play a leading role due both to the growing attention paid by scholars all around the world to these terms and to the increasing number of on-going initiatives both on the global and on the European scale.

In detail, according to some scholars, 40 global cities will become smart by the year 2020 (EIP, 2014) and by 2025 the number of Smart City all around the globe will climb from 21 of the 2013 up to 88 (Smart City Council, 2014a).

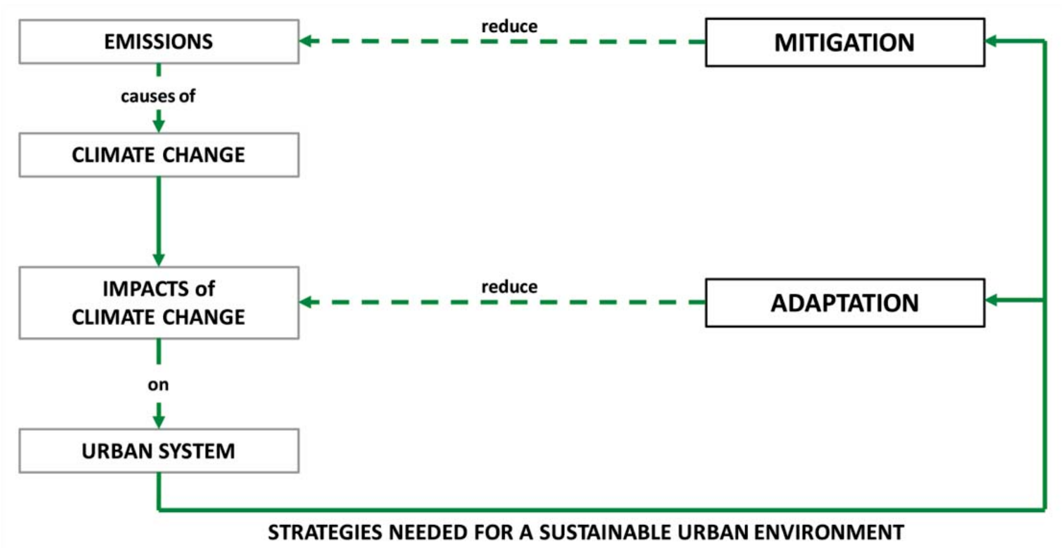


Fig. 1 Relations between urban system, climate changes, mitigation and adaptation (elaborated by Füssel et al., 2006)

Moreover, the European Commission has launched the European Innovation Partnership for Smart Cities and Communities for supporting "energy production, distribution and use; mobility and transport; and information and communication technologies (ICT)" to "improve services while reducing energy and resource consumption and greenhouse gas emissions" (EIP, 2013). Meanwhile, about 2100 cities all over the world have joined the "Making Cities Resilient" Initiative, launched in 2010 (UNISDR, 2012a) and, in December 2014, 100 cities have been selected by the Rockefeller Foundation Initiative for the "100 Resilient Cities Challenge" (Rockefeller Foundation, 2015). In Europe, a strategy addressed to enhance cities' adaptation to climate change in order to realize a "more climate-resilient Europe" has been established (EU, 2013) and the "LIFE+ Program" focused on urban resilience (EU LIFE, 2014) has been launched.

Despite the numerous on-going initiatives, both Smart City and Resilient City are still vague and fuzzy concepts. In the case of the Smart City, about 30 definitions have been proposed since 2000 (Caragliu et al., 2009). In current literature a Smart City is generally characterized by the wide use of Information and Communication Technologies (ICTs) for traditional infrastructures as well as for improving the active participation of human and social capital (Caragliu et al., 2009; Toppeta, 2010; Dameri, 2013). Such technology-based approach is often considered capable of dealing with different urban problems (Batty et al., 2012; Lee et al., 2013), guaranteeing both the quality of the urban environment and the sustainability of its development. On the opposite, it is worth noting that not many definitions of Resilient City have been provided even though the concept of resilience – developed since the Seventies – seems to be particularly suitable for urban areas (Galderisi, 2014). Focusing on the resilience concept, some authors emphasize that resilience is "in danger of becoming a vacuous buzzword from overuse and ambiguity" (Rose, 2007), "increasingly viewed in a rather vague and malleable meaning" (Brand and Jax, 2007). Notwithstanding, some organizations agree on a definition of a Resilient City as a city capable to withstand or absorb the impact of hazards, shocks and stresses through adaptation or transformation, in order to guarantee a long-term sustainability, as well as its basic functions, characteristics and structures (UNISDR, 2012b; ICLEI, 2014a; Resilient City, 2014).

Thus, based on the review of existing literature and embracing a systemic perspective, this contribution will highlight synergies and mismatches between the two concepts, identifying the main characteristics of a smart and resilient urban system and framing them into a conceptual model, showing the relationships between these characteristics and outlining the processes for building up smart and resilient cities, according to different temporal perspectives, from short to long-term.

This study represents a first step for shifting from current "silo" approaches - based on the fragmentation of knowledge, strategies and responsibilities (EEA, 2014) - towards a systemic one. Such an approach could better support cross-sectoral strategies and multi-objective actions, more and more crucial in the face of climate change in an era of limited public resources, for enhancing the capacities of complex urban systems to deal with more and more interconnected challenges.

2 SMART AND RESILIENT CITIES: TOWARDS NEW PARADIGMS?

Currently, Smart City and Resilient City are drawing an increasing attention by urban planners, decision-makers and municipalities, as shown by the proliferation of academic researches, as well as of institutional initiatives on these topics. Thus, Smart City and Resilient City are becoming widespread labels, despite the lack of shared definitions.

Approaching the terms, the first issue arising refers to their definition as concept or paradigms: some scholars indeed refer to the Smart City as a paradigm (Auge et al. Blùm, 2012; New City Foundation, 2014; Bencardino and Greco, 2014), while others consider it as a concept (Washburn, 2011; Cretu, 2012; Dameri, 2013; BSI, 2013; EIP, 2013). It is worth noting that also halfway positions exist, looking at the Smart City as an emerging paradigm (Kunzmann, 2014). The Resilient City is a recent term based on resilience that some scholars define as a concept (Rose, 2007; Davoudi, 2012) or even as a "new umbrella concept", able to take into account "risk management, ecological, sustainability or political sciences" (Chelleri, 2012), while others as a paradigm (Ercoskun, 2012; Rogers et al., 2012).

It has to be underlined that a paradigm can be defined as a "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1970); whereas a scientific concept is generally represented through three parts: a label, a theoretical definition that permits "others to understand our theory and be able to criticize and reproduce our observations" and an operational definition that "translates the verbal meaning provided by the theoretical definition into a prescription for measurement" (Suppe, 1997).

Hence, due both to the lack of a shared scientific definition of the two terms and to the heterogeneity of city programs and initiatives addressed to improve urban smartness and/or resilience, it seems hard to define them as paradigms: both Smart City and Resilient City contribute in offering solutions and opportunities for urban problems but, so far, they do not represent a "universally recognized scientific achievements". On the opposite, they can easily considered as concepts: both of them are more and more used as urban labels (Hollands, 2008; Caragliu et al., 2009; Davoudi, 2012), numerous definitions of each term are currently available and, even though their operational definition is still at an early stage, some basic elements have been developed, such as domains (for the Smart City concept), characteristics and indicators.

Thus, according to such interpretation, definitions, evolution paths and goals of the two concepts will be reviewed and compared, highlighting their synergies and mismatches, as a starting point to develop an integrated operational approach to Smart City and Resilient City.

The Smart City concept has gained an increasing attention, in the last decade, by scholars, practitioners and decision-makers in conferences, scientific and political meetings, even though "a clear-cut, common definition of smart cities is still lacking" (Moser et al., 2014). The attention paid to this concept since the 2000 has significantly increased, not only in the scientific arena, as clearly highlighted by the search query data from Google Trends (fig.2), which provides information about how often, all over the world, a particular search-term is entered in respect to the total search-volume.

Studies and researches on Smart City developed in the last years, arising from different disciplinary fields and perspectives (academic, industrial, institutional) and focusing on different topics, have led to a number of heterogeneous definitions.

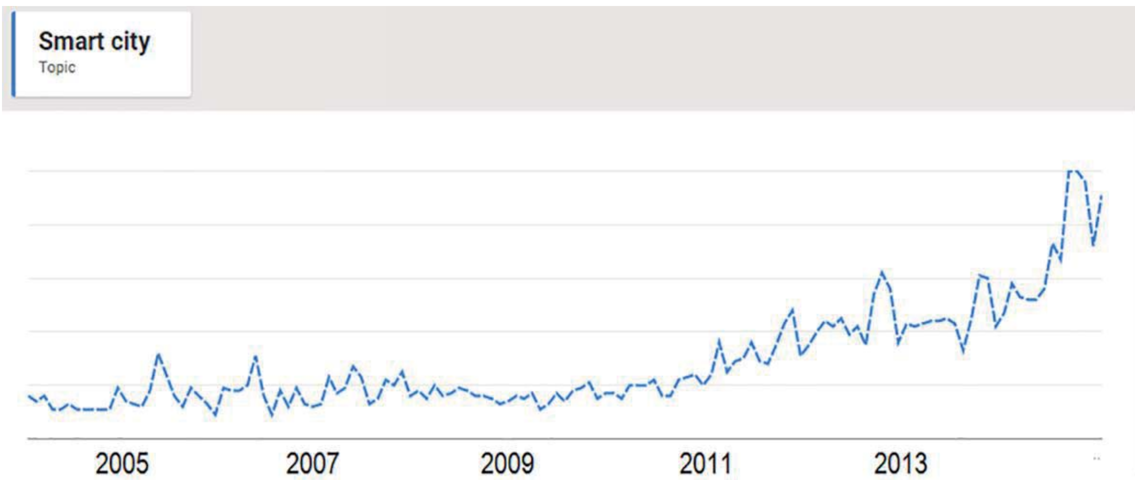


Fig. 2 Google Trends for "Smart City"

Some of them focuses on environmental issues, paying large attention to the efficient use of natural resources and to energy consumptions (EIP, 2013; Karnouskos et al., 2013, Kramers et al., 2014); others on socio-economic issues, highlighting the importance of social and human capital (Moser, 2001; Florida, 2003; Partridge, 2004; Glaeser and Berry, 2006; Giffinger et al., 2007; Dirks et al., 2010); others on institutional aspects, emphasizing the potential of ICTs in improving current decision-making processes and supporting the empowerment of local communities (Coe et al., 2001; Eger, 2009; Paskaleva, 2009).
Nevertheless, although the large variety of studies and researches focuses on different aspects, they agree on the crucial role of ICTs (Mosannenzadeh and Vettorato, 2014), assigning to technology different weights, according to the different disciplinary perspectives. Summing up, the numerous definitions of Smart City currently available bring out a variety of approaches and interpretations of the concept, although this multiplicity can be effectively reduced to two broad categories:

- a first one comprises the definitions referred to a "technology-based" approach, mainly focused on urban physical infrastructures (e.g., Hall, 2000; STERIA, 2011; Lazaroiu and Roscia, 2012; Aoun, 2013)
- a second one includes the definitions based on a holistic approach to the Smart City, capable to take into account the numerous and interconnected components that characterize an urban system (e.g., Giffinger et al., 2007; Nam and Pardo, 2011; Lee et al., 2013; Papa et al., 2013).

Among the numerous collected and analyzed definitions (approximately 30), the most relevant ones have been selected (Tab. 1), based on the number of quotations of the article comprising such definitions reported by Google Scholars. It is worth noting that all the selected definitions, which represent the most cited ones, refer to the second category. According to some scholars (Moir et al., 2014), also the "Resilient Cities is a concept growing in use". The term appeared in 2002 in the "Resilient Communities Program Concept" and it was used by Pickett et al. (2004) as a "*metaphor (…) to help link ecology and planning*".

Reference	**Definition**	**Citations**
Caragliu et al. 2009	We believe a city to be 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.	358
Komninos N. et al., 2011	The Smart Cities concept (…) is connected to notions of global competiveness, sustainability, empowerment and quality of life, enabled by broadband networks and modern ICTs.	291
Giffinger R. et al., 2007	A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens.	207
Nam T., Pardo T.A., 2009	Smart city integrates technologies, systems, infrastructures, services, and capabilities into an organic network that is sufficiently complex for unexpected emergent properties to develop.	103
Odendaal N., 2003	A smart city or region (…) is one that capitalizes on the opportunities presented by Information and Communication Technology (ICT) in promoting its prosperity and influence.	93
Batty M. et al., 2012	A Smart City is a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies. Smart cities are also instruments for improving competitiveness in such a way that community and quality of life are enhanced.	87

Tab.1 Smart City Definitions

The term was largely widespread thanks to the book edited by Vale and Campanella (2005) and titled "The Resilient City". The volume focused on the persistence of cities in the face of disasters and namely on their capacity to "rebound from destruction", being the cities "among humankind's most durable artifacts". Nevertheless, only recently the term "Resilient City" is gaining importance both in scientific debate and on the institutional level. Indeed, the Google Trends query for "Resilient City" (Fig. 3) highlights that the term entered the search queries in 2012, after the Sandy Hurricane that caused about 19 billion dollars of total damage. Such trend is arguably related to the priorities of national and local governments, which - in the face of the human and economic losses due to climate-related events - pushed towards the adoption of strategies and initiatives aiming at enhancing urban resilience, thereby promoting studies and research on this issue.

Also for the Resilient City concept, heterogeneous definitions are available; some of them have been provided by scholars (Newman et al., 2009; Fusco Girard et al., 2012), others by institutions (UNISDR, 2012a), large international organizations (World Bank Group, 2011) or private foundations (Rockefeller Foundation, 2015). Nevertheless, all the available definitions agree on the main idea that a resilient city is a city capable to absorb external pressures or to adapt or transform in front of such pressures, guaranteeing the safety of settled communities and the preservation of its basic functions during a crisis. Referring to the same temporal span, it is worth noting that the total number of definitions of the term Resilient City that can be found in current literature is by far lower than those available for Smart City. The most quoted definitions or the most widespread on the international level are shown in Table 2. Nevertheless, it has to be underlined that despite the definitions of Resilient City are fewer than those related to the Smart City, this concept roots in the wide research field focused on resilience, and namely on the resilience of social-ecological systems (Adger et al., 2005; Folke, 2006; Brand and Jax, 2007), to which a growing attention has been paid since the 2000 (Fig. 4). Numerous studies and researches have been carried in the last decades on the resilience of socio-ecological systems in the face of heterogeneous pressure factors, such as:

- natural hazards/climate change (e.g., Sapountzaki, 2010; Bahadur et al. , 2010; Jabareen, 2013; IPCC, 2013; Galderisi, 2014);
- energy consumptions and oil dependency (e.g., Newman et al., 2009; Hopkins, 2008; North, 2010);
- economy (e.g., Rose, 2007; Drobniak, 2010; Simmie and Martin, 2010).

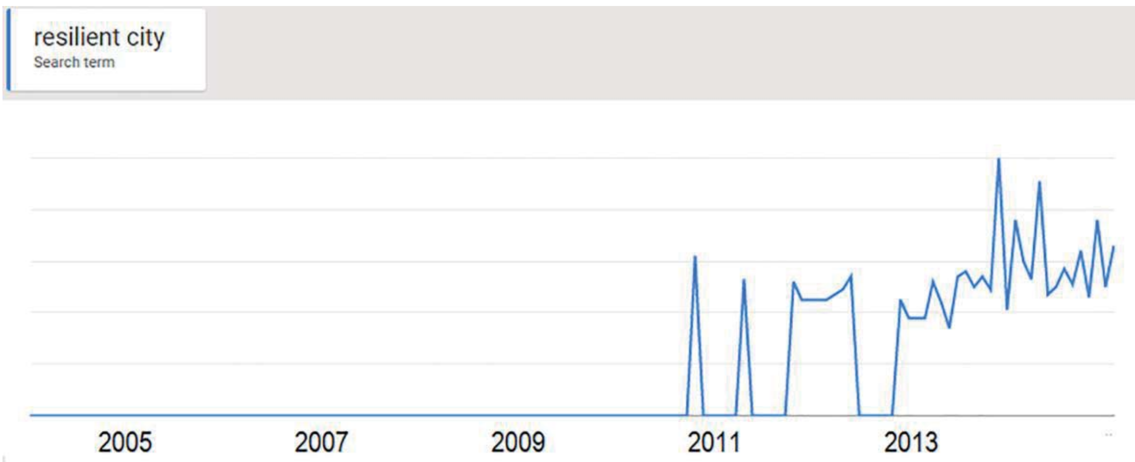


Fig. 3 Google Trends for "Resilient City"

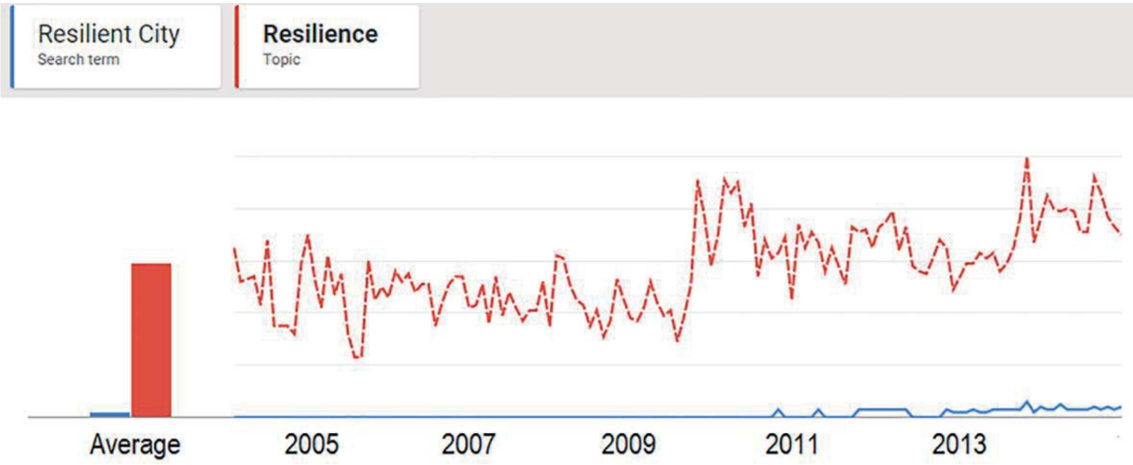


Fig. 4. Google Trends for "Resilience" (red) and for "Resilient City" (blue)

However, here we will refer only to the definitions of Resilient City, purposely neglecting the numerous and heterogeneous definitions of resilience, in order to allow a more immediate comparison with the Smart City definitions. Similarly to the case of Smart City, even in the most commonly used definitions of Resilient City there is a tendency to take into account different disciplinary perspectives, considering social, economic and environmental factors and their interrelationships as a key for an effective understanding of the complexity of urban systems and namely of their behaviors in the face of heterogeneous pressures. Briefly, according to the proposed definitions, the Smart City is a widespread label underlying a vision of the city based on the potential of ICTs as a key tool "to fuel sustainable economic growth and a high quality of life" (Caragliu et al., 2009).
The Resilient City promotes a vision of the city in which efforts are addressed to increase the ability of the city to respond to heterogeneous pressure factors (climate, environmental, energy and economic), with the ultimate aim of ensuring a higher quality of life and sustainable urban development. Furthermore, numerous scholars point out that ICTs, key tools for increasing urban smartness, could play a significant role also in reducing urban vulnerability and improving cities' resilience.

Reference	Definition	Citations
Newman et al., 2009	Resilient cities have built-in systems that can adapt to change, such a diversity of transport and land-use systems and multiple sources of renewable power that will allow a city to survive shortages in fuel supplies.	344
Nijkamp P. et al., 2012	A resilient city is also a creative city, able to reinvent a new equilibrium against destabilizing external pressure. It multiplies the potential of people to build new opportunities/alternatives.	13
Resilient Communities Program Concept, 2002	Resilient City is a city that supports the development of greater resilient in its institutions, infrastructure and social and economic life. Resilient cities reduce vulnerability to extreme events and respond creatively to economic, social and environmental change in order to increase their long- term sustainability.	n.a.
UNISDR, 2012	A resilient city is characterized by its capacity to withstand or absorb the impact of a hazard through resistance or adaptation, which enable it to maintain certain basic functions and structures during a crisis, and bounce back or recover from an event.	n.a.

Tab.2 Resilient City Definitions

According to Heeks et al. (2013), indeed, "ICTs can help strengthen the physical preparedness of communities by helping those communities to optimize the location of physical defenses" and "can also strengthen institutions needed for the system to withstand the occurrence of climatic events".
Summing up, the analysis and the comparison among the definitions of Smart City and Resilient City highlight important commonalities between the two concepts, even though the lack of clear-cut common definitions and the fact that both concepts are still evolving make a conclusion still open and harbinger of future research developments.

3 THE EVOLUTION OF THE SMART AND RESILIENT CITY CONCEPTS

In the previous paragraph, the definitions of the Smart City and of the Resilient City have been compared with reference to a time span ranging from the 2000 to the 2014. However, the considered definitions already refer to an end-point, although not a final one, of an evolutionary process that is far more temporally extended since the roots of each concept, can be traced in research works carried out some decades ago. Hence, to better understand current similarities and/or differences among the two concepts of Smart and Resilient City, the evolution path of each concept will be sketched, highlighting the variety of contributions arising from different disciplinary fields that contributed to building up their current meanings.
In respect to the Smart City, it is worth reminding that the term "smart" has been primarily used in the Nineties by the Smart Growth American movement, which "refers to policies for the management of growth of urban and suburban settlement and to a set of principles for designing". Moreover, the Smart Growth also refers to "an idea of the city" capable to "provide an alternative to sprawl" (Pellegrini, 2003). The movement, mainly referred to the development of new residential areas, was addressed to reduce soil consumption and sealing, promoting more sustainable developments (Moccia, 2012).
Nevertheless, the main roots of the term Smart City as it is currently interpreted "have to be traced in some of the phenomena that characterized the Eighties and the Nineties, namely, in the evolution and diffusion of ICT and in their outcomes in terms of globalization of economy and markets" (ABB-Ambrosetti, 2012; Papa et al., 2013). The term Smart City was coined at the beginning of the Nineties in order to point out an urban development more and more dependent on technology and on innovation and globalization phenomena, mainly by an economic perspective (Gibson, Kozmetsky and Smilor, 1992).
Thus, since the Nineties ICT represented a key tool for increasing efficiency, attractiveness and competitiveness of cities. Starting from the early 2000s, large industries such as Cisco, Ericsson, IBM have significantly invested in the integration of ICTs within cities, strongly supporting the spread of a techno-centered approach to the Smart City concept. Nevertheless, in the mid of the 2000s a human-centered approach, focused on the key role of the human and social capital as starting levers for a "smart" urban development, began to take shape. In the second half of the 2000s, thanks to the study of Giffinger et al. (2007), the Smart City concept gained larger room in the scientific debate. Giffinger et al. (2007) provided a model of Smart City, interpreted as "a city well performing in 6 characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens" and a method for measuring and comparing urban smartness. The six characteristics - or, better, the sectors in which a Smart City has to ensure high performances - can be identified as follows: smart economy; smart people; smart governance; smart mobility; smart environment; smart living.
Hence, this study paved the way to an integrated approach to the Smart City concept and, based on this numerous scholars have recently provided an interpretation of the smart city as a city in which ICTs are addressed to improve the overall urban performances and, above all, the quality of life of citizens. Among them, the research work carried out by Caragliu et al., (2009), focused on the relationships among technological and social aspects, intellectual capital, health and governance issues, and the studies of Mark

Deakin (2012), who proposed the model of the "Triple Helix" for promoting social innovation, stressing on the close relationships between sustainable development and Smart City.
As a result, recently "a broader conceptualization of Smart Cities places emphasis on good city governance, empowered city leaders, smart or 'intelligent citizens' and investors in tandem with the right technology platform" (Moir et al., 2014), supporting strategies addressed to improve both "hard" (infrastructures, ICTs, etc.) and "soft" urban components (human and social capital).
As mentioned above, the term "Resilient City" gained large attention by institutions, policy makers and scholars after the Hurricane Sandy that, in 2012, hit the North Eastern part of the USA and the city of New York, causing 43 deaths and economic damage for about 19 billion dollars. In the last years, the constantly increasing popularity of the concept is mainly due to its widespread use and promotion by international organizations (eg. the UNISDR that in 2010 launched the Making Cities Resilient campaign, addressed to involve local Authorities and enhance urban resilience in the face of natural and man-made hazards); private organizations (eg. the Rockefeller Foundation, which identifies specific "challenges" that cities have to deal with - from natural hazards to social issues – promoting the initiative "100 Resilient Cities") and associations of cities and local governments (eg, ICLEI that deals with urban resilience against climate-related impacts).
Although the concept of Resilient City has recently come to the fore, the studies on resilience have been developed since the Fifties through different disciplinary fields, from physics to psychology, from ecology to management science. Referring to previous research works for an exhaustive description of the evolution path of the resilience concept (Martin-Breen and Anderies, 2011; Alexander, 2013; Galderisi, 2014), we will here point out some milestones along this path. Resilience found large room in Ecology during the Seventies, thanks to Holling (1973) that firstly focused on the behavior of natural systems in the face of external perturbations. In the mid of the Nineties, Holling provided a clear distinction between an engineering and an ecological approach to resilience. According to Holling (1996), engineering resilience refers to stability, efficiency, constancy, predictability, return time to a previous state and, above all, to the idea of a single, stable equilibrium, using "resistance to disturbance and speed of return to equilibrium (…) to measure the property". On the opposite, ecological resilience emphasizes "conditions far from any equilibrium steady state", recognizes the existence of multiple equilibrium states and can be measured according to "the magnitude of disturbance that can be absorbed before a system changes its structure". Thus, ecological resilience focuses on the twofold possibility for a system to absorb changes, maintaining its main features, below a given threshold of disturbance, or change its state, moving towards a different one, not necessarily better than the previous one, above such a threshold.
The engineering perspective has been largely widespread in the studies on risks, as opportunity for improving cities' capacities to deal with emergency and recover from disasters (e.g., IFRC, 2011; Vale and Campanella, 2005; Gunderson, 2010): according to this perspective, resilience has been interpreted as the capacity of a system to return to a previous equilibrium steady-state, to "bounce back" after disturbances.
The "ecological" approach to resilience has been significantly strengthened when the focus of studies and researches on resilience shifted from natural to socio-ecological systems and intertwined with those related to the complex adaptive systems, capable of learning from experience, processing the information, adapting and even transforming themselves in face to changes. By this perspective, resilience was less and less conceived as a bounce-back to a previous state and progressively adapted to the behavior of complex systems, that is non-linear, self-organizing, characterized by uncertainty and discontinuities (Berkes et al., 1998; Holling, 2001; Walker et al., 2004; Bankoff et al., 2004).
Recent research works have further extended the concept of resilience, defining the latter as a "dynamic interplay of persistence, adaptability and transformability across multiple scales" (Folke et al. 2010). Moreover, some scholars have pointed out the importance of "continual learning" (Cutter et al., 2008), providing an idea of resilience as 'bouncing forward', which includes the idea of 'improvement' of systems' essential structures and functions (IPCC, 2012).

Hence, current approaches to resilience seem more appropriate to grasp the complexity of urban systems' evolution (Davoudi, 2012; Chelleri et al., 2012) and suitable for framing urban policies in the face of a large set of heterogeneous phenomena, from the climate-related impacts to the scarcity of resources. In some cases, indeed, the concept of persistence, addressed to improve the capacity of a system to withstand sudden impacts and to rapidly and effectively recover previous conditions, can be significant. In other cases, being current conditions unsustainable or inadequate, novelty and innovation become crucial to drive the system's transition towards new conditions. The milestones of the evolution path of the resilience concept are shown in fig. 6; it has to be noticed that the Resilient City definitions mainly refer to the more recent interpretation of Resilience, since it is generally interpreted as a city capable to absorb, adapt and/or change in the face of external pressures. However, although the Resilient City concept is nowadays largely widespread among planners and decision makers, some scholars highlight the numerous criticalities that may arise when the resilience concept is applied to urban systems. For example, human intervention is not taken into account in the "adaptive cycle" of ecological systems, while it is crucial in case of urban systems; moreover, the need for clarifying the goals - "resilience to what ends?" – as well as the field of action - "resilience of what to what?" – and the beneficiaries - "resilience for whom?" – of policies addressed to enhance urban resilience have been largely emphasized (Davoudi, 2012).

These criticalities point out the need for improving urban resilience taking into account both "hard" and "soft" components of urban systems. The former refer to structural, technical, mechanical, and cyber systems' qualities, capabilities, and functions of infrastructures. The latter are "related to family, community, and society, focusing on human needs, behaviors, psychology, relationships, and endeavors" (Kahan et al., 2009). The difference between "hard" and "soft" components is also highlighted by some of the major networks devoted to the resilience issues (e.g., ICLEI, 2014; ACCCRN, 2012) and it is largely mirrored in the field of adaptation strategies and measures that are generally distinguished between "hard", when they "involve capital-intensive, large, complex, inflexible technology and infrastructure", and "soft", when they "prioritize natural capital, community control, simplicity and appropriateness" (Hallegatte, 2009; Sovacool, 2011).

Summing up, even though the term Smart City is rooted in the evolution and spread of ICTs and in their outcomes in terms of globalization of economy and markets, along its evolution path it has been increasingly used to indicate a city in which ICTs are addressed to improve the overall urban performances and, above all, the quality of life of citizens. The concept of resilience – which underlies the Resilient city concept – extending the concept of resilience from natural to socio-ecological and urban systems and embracing change and complexity, is more and more interpreted as a key concept for improving cities' performances in the face of the different factors currently threatening their future development, by managing a large set of interconnected properties and adaptive capacities (Norris et al., 2008; Galderisi and Ferrara, 2012).

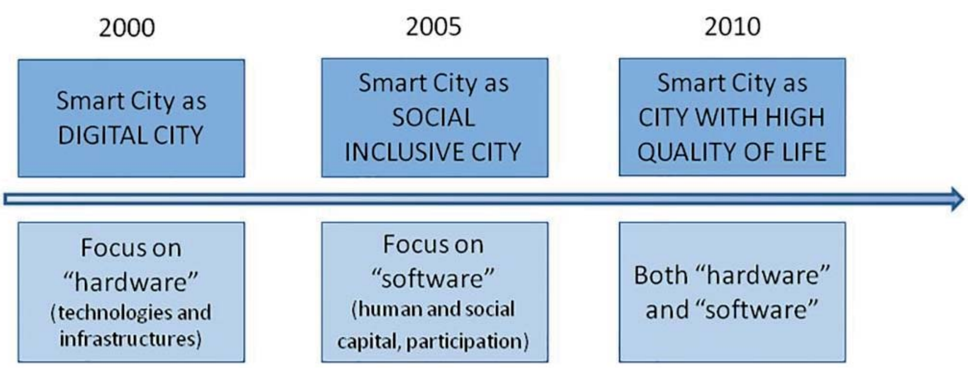


Fig. 5 Evolution of the Smart City concept

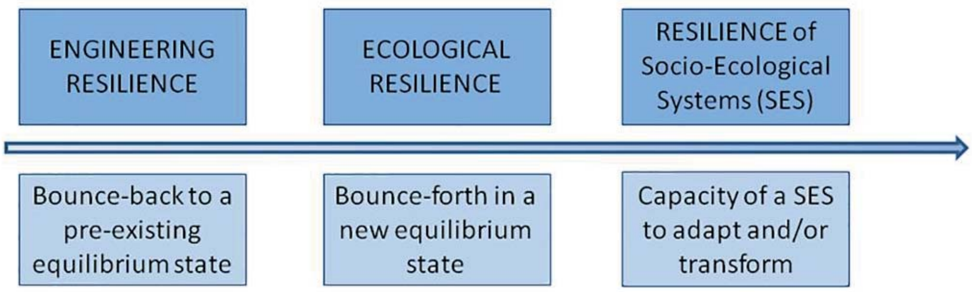


Fig. 6 Evolution of the Resilient City concept

Thus, both the concepts are currently interpreted as key concepts for improving urban performances, even though the Smart City concept puts large emphasis on the role of ICTs, while the Resilient City concept focuses on the inherent capabilities of cities to deal with the heterogeneous factors (from hazards to climate change, from environmental degradation to poverty) threatening cities' development. Moreover, both of them aim at providing strategies and measures acting on "hard" (infrastructures, technological systems, etc.) and "soft" components (capacities and behaviors of communities and institutions) of urban systems.

4 THE AIMS OF THE SMART AND RESILIENT CITY CONCEPTS

Based on the analysis of the definitions and of the evolution paths of the Smart and Resilient City concepts some commonalities between the two concepts can be outlined, even though, as clearly highlighted in the previous paragraph, each concept has its own peculiarities. To further investigate the relationships between the two concepts, the main goals of each concept have been deepened.

According to the vast scientific literature on these issues, both the Smart City and Resilient City are mainly addressed to improve sustainability and increase the quality of life, although each concept seem to pursue these objectives following different paths.

As regards sustainability, in the Smart City this goal is primarily pursued through a wide use of ICTs that, allowing a more efficient and effective management of networks (energy, transport, etc.), may led to a significant reduction in energy consumptions. In a broader sense, "a smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" (ITU, 2014).

Nevertheless, it is worth noting that the large use of ICTs may also negatively affect sustainability, at least in respect to:

- environmental aspects, in that the production of ICTs involves an intensive use of raw materials that are assembled in not recyclable devices (Wagener, 2008) and, above all, the use of ICTs induces high-energy consumption (Viitanen and Kingston, 2014). As remarked by Wagener (2007), indeed, "large cities with a high concentration of knowledge workers, office buildings, and ICT are likely to find that ICT energy use is significantly higher than national averages" (Wagener, 2007). Nevertheless, "green IT is a new emerging field of study that brings together both environmental sustainability and information technology (IT) and explores the ways in which they connect with each other" (Lombardi, 2011);
- socio-economic aspects, in that the use of "ICTs would increase the risk to human health, including stress and conflict due to inequality" (Viitanen and Kingston, 2014) among individuals and/or institutions that have access to ICT and that, above all, are able to use them properly.

Thus, according to current literature, social and environmental sustainability represent a "major strategic component of smart cities" (Caragliu et al., 2009), even though relevant aspects, such as the issues related to the potential of green ICTs or to the social inclusion, should be further investigated.

According to Folke (2002), resilience and sustainability are tightly connected concepts, due to the need for creating and maintaining prosperous social, economic and ecological systems also in the face of uncertain events. Some scholars emphasize that resilience represents a "necessary approach to meet the challenge of sustainable development" (Chelleri et al., 2012) or a way of thinking for planning sustainable cities, capable to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987).

Nevertheless, similarly to what has been highlighted for the smart city, some scholars point out some inconsistencies between resilience and sustainability (TURAS, 2012; Redman, 2014): in detail, while resilience puts large emphasis on uncertainty and discontinuities and is largely interpreted as the result of the dynamic interplay of persistence, adaptability and transformability (Davoudi, 2012), sustainability is often interpreted in a "fail-safe" approach as a concept aimed at "achieving stability, practicing effective management and the control of change and growth" (Ahern, 2011)

The increase of the quality of life is the other main goal of both Smart and Resilient City. In the Smart City, the widespread use of ICTs allows, for example, "to improve mobility on many levels, increasing spatial and a-spatial accessibilities to jobs, leisure, social opportunities and so on, thereby enabling the citizenry to increase their levels of life satisfaction" (Batty et al., 2012). Moreover, ICTs allow the reduction of energy consumptions and CO_2 emissions by allowing citizens to get a better air quality and a better environment.

The empowerment of citizens thanks to the use of ICT (Navarrete, 2012) represents a largely emphasized feature of the Smart City. It refers to a process of "social engagement" that creates a widespread sense of social cohesion, a significant awareness of the issues relevant to the community and allows people to propose and activate common objectives and actions (Zani, 2012). Thus, citizens' empowerment is a way to support decision-making processes based on a broad-base views of citizens and, therefore, to ensure development processes more participatory, collaborative and, in one, capable to effectively respond to the need of local communities.

Nevertheless, according to some scholars, "the paradox is that the same networked technologies that offer opportunities for empowerment can be used against civil rights for surveillance and censorship, or at worst, direct oppression" (Viitanen and Kingston, 2014).

Moreover, even though numerous scholars underline that the Smart City is addressed to increase "livability" (Toppeta, 2010; Chourabi et al., 2012; Smart City Council, 2014a), most of available definitions put "emphasis on business-led urban development" (Caragliu et al., 2009).

For example, the main aim of the study on European Smart Cities carried out by Giffinger et al. (2007) is to analyze the medium-sized European cities in order to find out their strengths and improve their competitiveness. The Smart City concept is, indeed, "principally open to any societal goals linked to it, but due to its focus on innovation systems, priority is given implicitly to competitiveness and economic growth" (Wolfram, 2012).

Also the Resilient City concept is addressed to increase the quality of life. A resilient city is, indeed, capable to absorb, adapt and/or change in the face of the main environmental challenges threatening its future, in order to preserve natural and man-made resources and, above all, to guarantee citizens' safety. It is worth reminding that, according to the five-stage model of human needs outlined by Maslow in 1943, safety is one of the basic needs that people have to fulfill, immediately after the biological and physiological ones. Therefore, to ensure the safety of people is a key objective for guaranteeing high levels of quality of life.

As it clearly arises from the above, the two investigated concepts, Smart City and Resilient City, show numerous commonalities, despite some differences. As regards the former, it has to be noticed that both of them result from a long and multidisciplinary evolution path capable to take into account the multiple and interrelated aspects of a complex urban systems, are addressed to pursue goals related to sustainability and quality of life and can be implemented through "hard" and "soft" measures.

Among the main differences, it is worth noting that while the spread of the Smart City concept has been strongly supported by large industries, the Resilient City concept has been mainly promoted by international organizations as well as by associations of cities and local governments.

Moreover, whereas the common ground among the definitions of Smart City can be found in the use of ICTs as a tool for empowering cities and citizens in the face of heterogeneous challenges, but above all as a key tool to fuel economic growth and competitiveness, the common ground of the definitions of Resilient City can be traced in the enforcement of the fundamental capacities of an urban system to deal with external pressures (from climate change to environmental degradation). Nevertheless, according to the more recent interpretations of the Smart City concepts, ICTs should be better addressed to solve long-term environmental challenges and to improve cities' resilience rather than primarily focus on consumer electronics. According to Heeks et al. (2013), indeed, "ICTs can help strengthen the physical preparedness of communities by helping those communities to optimize the location of physical defenses" and "can also strengthen institutions needed for the system to withstand the occurrence of climatic events".

Hence, the Smart City concept seems more and more to underlie a process, a multi-objective strategy of integrated urban and ICT development, capable to tackle problems of economic competitiveness but also of social equity and environmental performance (Wolfram, 2012). Such a process should allow cities to "become more livable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Therefore, a better integration between the two often separated concepts and following strategies seem to be widely desirable and already pursued by some. Nevertheless, such integration has to be based on a robust scientific approach capable to provide methodological and operational tools for promoting cross-sectoral and multi-objective strategies capable to improve urban smartness and resilience, by providing citizens with a better urban environment capable to favor cohesion, sense of community and, meanwhile, safety and prosperity. Moreover, it is worth emphasizing that a multi-objective strategy addressed to build up a smarter and a more resilient city should be carefully tailored on the peculiarities of local contexts, in that each city has to define its own objectives and priorities, through a shared and participatory process (BSI, 2014).

5 BUILDING UP SMART AND RESILIENT CITIES: A CONCEPTUAL MODEL

According to the preliminary findings presented in the previous paragraph, it seems possible to state that, on the one hand, the Smart City concept is widely interpreted as a process capable to tackle urban problems related to economic competitiveness but more and more focused on issues related to social equity and environmental performances (Wolfram, 2012). On the other hand, the Resilient City is largely interpreted as a process addressed to empower cities and citizens to cope with external - environmental, social, economic - pressures. Hence, due to the relevant synergies between the two concepts, some authors emphasize the increasing area of overlapping among them, highlighting that resilience is more and more frequently included among the Smart Cities' objectives and that smart initiatives are often addressed to allow cities to "become more livable and resilient and, hence, able to respond quicker to new challenges" (Kunzmann, 2014). Moreover, some international organizations and networks as well as numerous cities are promoting integrated strategies for building up smarter and more resilient cities, as a key step for effectively counterbalance the challenge of climate change as well as for pursuing a better integration between mitigation and adaptation strategies (Klein et al., 2005).

For example, the American Planning Association (APA) has "created a Smart Cities and Sustainability Task Force, whose mission is to address advances in technology and innovation to cultivate cities which are smarter, more resilient and sustainable" (McMahon, 2014); the Asian Cities Climate Change Resilience Network (ACCCRN), funded by the Rockefeller Foundation, is striving for "developing smarter, resilient cities in India" (ACCCRN, 2015).

Nevertheless, as mentioned above, an effective theoretical framework – which is crucial for developing operational tools capable to support integrated and multi-objective strategies – is still missing. To fill this gap, the study focuses on the characteristics of Smart and Resilient cities and provides some hints for guiding a process aiming at improving cities' smartness and resilience in the face of climate change. In detail, based on the available scientific literature, first of all the characteristics common to both the Smart and the Resilient city concepts have been selected; then, grounding on previous studies focused on the Resilient City (Bahadur et al., 2010; Martin-Breem and Marty Anderies, 2011; Galderisi, 2013) and on the Smart City (Sinkiene et al., 2014; BSI, 2014) the most important ones for each concept have been identified. In the following (tab. 3 and 4) all the selected characteristics have been listed and briefly explained.

Resilient City Concept	Characteristic	Smart City Concept
The "capacity to maintain a system in its current stability domain" (Berkes et al., 2002)	Adaptability	The capacity to adapt to unforeseen situations (Ratti & Townsend, 2011)
"It's the ability to constantly assess, take in new information, reassess and adjust your understanding of the most critical and relevant strengths and weaknesses and other factors" (Rockefeller F., 2014)	Awareness	It is related to the capacity of knowing and understand the urban potentialities (Giffinger et al., 2007)
It refers to the existence of multiple opportunities and incentives for a broad participation of stakeholders, as in public-private partnerships (Godschalk, 2003).	Collaboration	It is related to coordination and is defined as a step of the city technology harmonization, characterized by synergies and interactions between elements, resource and actors (BSI, 2014)
It represents the achievement of higher level of functioning by adapting to new circumstances and learning from the disaster experience (Maguire & Hagan, 2007)	Creativity	It is related to the creative capital that co-determines, fosters and reinforces trends of skilled migration (Florida, 2003; Caragliu and Nijkamp, 2008)
Diversity of species performing critical functions, diversity of knowledge, institutions and human opportunity and diversity of economic supports all have the potential to contribute to sustainability and adaptive opportunity (Berkes et al., 2002)	Diversity	It can be referred to the social and ethnic plurality (Giffinger et al., 2007) or to the diversity of specific elements, e.g. transportation modes (Caragliu et al., 2009).
"Fundamental property for service system and entails that performance are realized with modest resource consumption" (Fiksel, 2003)	Efficiency	It is related to the capacity of systems and infrastructures to optimize their performances (Aoun, 2013; Kramers et al., 2014).
It is a key aspect of adaptive capacity when unexpected events occur (Godshalk, 2003) and it is the capacity of a system to cope with an impact without being permanently altered (Tasan-Kok, 2013)	Flexibility	It is the ability to change, specifically referred to labor market and human capital (Giffinger et al., 2007)

Resilient City Concept	Characteristic	Smart City Concept
"Innovation is seen as novel ways of doing things, or how new things can be made useful, and refers to incremental or radical changes in ideas, practices, and products; including novel ways of organizing society, changing its rules and institutions" (Ernstson et al., 2010)	Innovation	Changes made to something established, or a new introduction as new methods, ideas, or products, to achieve desirable outcomes that result in small but significant improvement (BSI, 2014)
Dynamic systems require to constantly revise existing knowledge to enable the management of the system and the adaptation to change (Stockholm Resilient Centre, 2014)	Learning	The human ability to gain knowledge or skill through ICT (Coe et al., 2001) or as the collection of data and their elaboration (Wolfram, 2012)
The ability to create networks of non-identical elements, or actors, called "nodes" that are connected by diverse interactions or links (Chuvarayan et al., 2006)	Networking	The capacity to connect computers and devices through communications channels that facilitate communications among users, allowing them to share resources and services (BSI, 2014)
The capacity to "build trust and relationships needed to improve legitimacy of knowledge and authority during decision making processes", as well as "create a shared understanding and uncover perspectives that may not be acquired through more traditional scientific processes" (Rockefeller F., 2014)	Participation	The capacity to involve civil society organizations, stakeholders, communities and citizens in policy-making and public debate (BSI, 2014)

Tab. 3 Common characteristics of Resilient City and Smart City

It is worth underlining that most of the literature related to the resilience of socio-ecological systems focuses on the concept of self-organization, by interpreting this concept as a key feature of a resilient system (Walker et al., 2004; Chuvarajan et al., 2006; Folke et al., 2006). However, according to numerous scholars, self-organization has been here intended as an inherent characteristic of complex systems, such as the urban systems. It "can be defined", indeed, "as the spontaneous emergence of global structure out of local interactions. Spontaneous means that no internal or external agent is in control of the process (…). This makes the resulting organization intrinsically robust and resistant to damage and perturbations" (Heylighen, 2008). According to such interpretation, self-organization has not been included among the selected characteristics. Nevertheless, self-organizing mechanisms that will arise as a consequence of the internal and external changes of the systems should be adequately understood and monitored.

Then, to better understand how these characteristics act and interact for improving the response capacities of complex urban systems in the face of climate change, a further step is required. Climate change is indeed a challenging threat that requires long term as well as short-medium term strategies. Thus, on the one hand, long-term strategies capable to reduce GHG emissions and energy consumptions, by promoting cities' transition from current energy consuming development patterns towards low-carbon patterns, are required; on the other hand, short-medium term adaptation strategies, aimed at reducing the vulnerability of urban systems to the heterogeneous impacts of climate-related phenomena, ranging from sudden (e.g. flash floods, heat waves, etc.) to slow (e.g. droughts) phenomena and to improve cities capacities to better cope with more and more "beyond the expected" or even "unexpected" phenomena, have to be developed.

Characteristic	Concept	Definition
Connectivity	Resilient City	It is related to "the density of the links within the network, i.e., the number of links divided by the maximum possible number of links" and to the "reachability, or the extent to which all the nodes in the network are accessible to each other" (Janssen et al., 2006)
Knowledge	Resilient City	The capacity to elaborate knowledge and learn from management mistakes, protecting a system from the failure due to subsequent management actions based on incomplete knowledge and understanding (Berkes, 2004)
Memory	Resilient City	"The ability of a system to preserve knowledge and information" (Folke et al., 2005)
Modularity	Resilient City	"It is the degree to which a system's components may be separated and recombined" (Elmqvist, 2013)
Persistence	Resilient City	System's ability to withstand an impact, preserving its own characteristics and structure, except for a temporary departure from the ordinary functioning conditions (Folke et al., 2010)
Redundancy	Resilient City	Spare or superfluous "elements, systems, or other units (..) capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality" (Bruneau et al., 2003; Walker and Salt, 2006; Schultz et al., 2012; Tyler & Moench, 2012).
Resistance	Resilient City	The degree to which systems are displaced (or disturbed) by a given physical force or pressure (Carpenter et al., 2001)
Resourcefulness	Resilient City	"The capacity to (…) mobilize resources when conditions exist that threaten to disrupt some element, system, or other unit of analysis" including "the ability to apply material and human resources to meet established priorities and achieve goals" (Bruneau et al., 2003)
Robustness	Resilient City	The "ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function" (Bruneau et al., 2003).
Transformability	Resilient City	"Capacity of people to create a fundamentally new social-ecological system when ecological, political, social or economic conditions make the existing system untenable" (Walker et al., 2004)
Anticipation	Smart City	Capacity to conceive future predictable scenarios. Indeed, a smart city can provide "tools to exploit various sources of information about human behavior to aid in the allocation of resources—land, water, transportation, and so on—as the city evolves" (Naphade et al., 2011)
Monitoring	Smart City	"The capacity to monitor all critical infrastructures is crucial for a smart city in order to better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens" (Hall, 2000)
Reliability	Smart City	Degree to which a measure repeatedly and consistently produces the same result (BSI, 2014)

Tab. 4 The most important characteristics of Smart City and Resilient City

It is worth stressing that, in respect to the different time spans (short-medium-long term) that characterize the response of a complex urban system in the face of climate change, the selected characteristics play different roles. Therefore, in order to highlight their roles and linkages in the different phases, the selected characteristics have been framed into a conceptual model (Fig. 7).

So far numerous and heterogeneous models on Smart and Resilient City have been developed; these models can be distinguished at least into three different categories:

- "theoretical" models that, based on scientific theories, are addressed to understand and represent cities' dynamics and development;
- "operational" models, which provide a vision for urban development and outline a path for achieving it;
- "hybrid" models, combining a solid theoretical background with some operational elements.

The Smart City literature is largely focused on "operational" models, defining intervention sectors for projects implementation (Lekamge and Marasinghe, 2013), despite the lack of a "solid theoretical framework for smart cities" (Harrison et al., 2011).

In the Resilient City literature, some "theoretical" models, addressed to investigate the main characteristics of a resilient city (Tyler and Moench, 2012; Davoudi, 2013; Galderisi, 2013), as well as some "operational" models aimed at supporting municipalities in developing strategies for disaster risk reduction (Mehrotra et al., 2009; Prasad et al., 2010) or for climate adaptation (e.g., Climate-Adapt Platform, 2014) have been carried out. Unfortunately, most of the two groups of models seem to travel separately, in that the operational models do not mirror the hints provided by the theoretical ones; only recently some "hybrid" models, based on a robust theoretical framework and providing some operational tools for improving urban resilience, have been developed (Tyler et al., 2014).

Hence, the conceptual model for building up smart and resilient cities in the face of climate related challenges represents one of the first attempts to develop an "hybrid" model, framing smart and resilient cities' characteristics along the different temporal stages that characterize the response of a complex urban system in the face of climate change (fig.7).

The model is structured as a cyclical process, based on the learning capacity of urban systems and characterized by the "dynamic interplay of persistence, adaptability and transformability" (Folke et al., 2010). The capacity of "continual learning" is considered as crucial both for the Smart and the Resilient City concept (Cutter et al., 2008; Sinkiene, 2014). According to Davoudi et al. (2013), it allows urban systems to resist "disturbances (being persistent and robust)", to absorb "disturbances (…) (being flexible and adaptable)" and to move "towards a more desirable trajectory (being innovative and transformative)". Hence, it may allow urban systems to improve their capacity both to "bounce-back" in the face of climate-related impacts or to "bounce forward", including the idea of anticipation and improvement of their essential structures and functions through long-term strategies (IPCC, 2012). Moreover, the most recent approaches to the resilience concept provide an interpretation of the latter as the "dynamic interplay of persistence, adaptability and transformability across multiple scales" (Folke et al., 2010): such a dynamic interplay allows a resilient system to extend its focus beyond resistance to shocks, including adaptive responses as well as long-term transformation in the face of future or unforeseen threats (Galderisi, 2014).

Therefore, learning capacity, persistence, adaptability and transformability have been classified as the key properties of a smart and resilient city or, better, as the main goals to which strategies and measures have to be addressed for improving cities' response in the face of climate change. The cyclical structure of the process is characterized by three different stages (strategies' definition, implementation and management) developing over time and connected through a feedback loop: such a structure emphasizes that a smart and resilient urban system does not represent a "fixed state" (Davoudi, 2012), but it results from a dynamic and continuous process. Learning capacity is at the base of the process and allows the system to start, revise or change the strategies addressed to achieve the key properties of a smart and resilient city. Despite the dynamic interplay of these characteristics over time and across space, it is worth noting that each of them gains relevance in a different time span: in the short term, strategies are generally addressed to improve cities' capacities to withstand the expected (or the most likely) climate-related impacts, by increasing system's persistence; in the medium term, strategies are addressed to enhance cities' capacity to cope with unexpected impacts, by improving system's adaptability; then, long term strategies, by improving cities' transformability, should drive urban transition towards novel development pattern, capable to reduce energy footprint of cities and, in so doing, to prevent future climate-related impacts.

Within the model, all the selected characteristics, according to their meanings and relevance, have been hierarchized and related to one or more of the identified key properties, which are the learning capacity, the persistence, the adaptability and the transformability. Such key properties can be improved by other subordinate characteristics that can be related to more than one key properties, such as the efficiency that is common to the persistence and the adaptability. In detail, learning capacity can be improved through strategies and actions addressed to enhance: networking capacity that allows to connect people and devices for exchanging data and information; monitoring capacity, which allows to constantly detect the conditions of an urban system; knowledge that allows to elaborate information about events and processes; memory, which allows to learn from past events in order to figure out possible future scenarios; collaboration, which favors interactions and synergies between different stakeholders; participation, which allows to involve people in the decision-making processes. Moreover, learning capacity is intended crucial for developing people and institutions' awareness about climate-related issues, to improve the capacity to anticipate likely future events, which can threaten urban systems, and, mainly grounding on monitoring and knowledge, to guarantee an effective management of the urban system along the time.

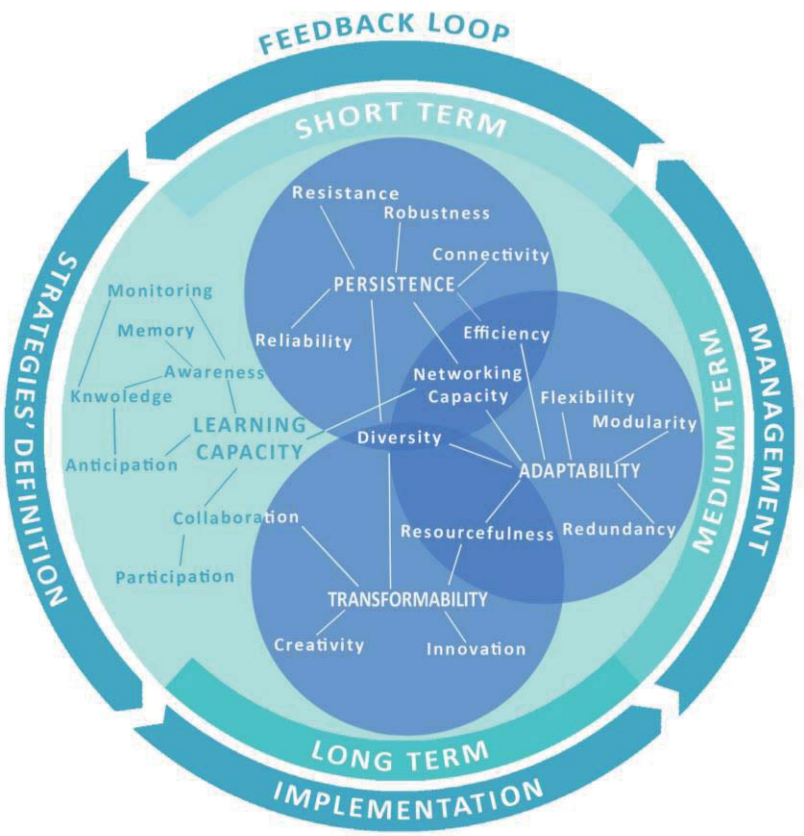


Fig. 7 The conceptual model: roles of and linkages among the capacities of a Smart and Resilient Urban System in the face of climate change.

Finally, as emphasized above, learning capacity provides inputs for enhancing persistence, adaptability and transformation of the system in the face of climate change: these properties, which come to the fore in different temporal stages, provide in turn information that, being continuously processed, can be used as an input to further increase the learning capacity (feedback loop).

Persistence, generally referred to the ability of an urban system to maintain the characteristics and structures in the face of a threatening factor, can be improved through strategies and actions addressed to enhance: robustness, which is the ability of elements and systems to withstand a given impact without suffering degradation or loss of function (Bruneau et al., 2003); resistance that allows the urban system to not be displaced (or disturbed) by a given pressure (Carpenter et al., 2001); reliability, which is the certainty of a result (BSI, 2014); efficiency, that is the capacity to optimize the performance with modest resource consumptions (Fiksel, 2003; Aoun, 2013; Kramers et al., 2014); diversity, related to the plurality of functions and of knowledge (Berkes et al., 2002); connectivity, related to the density of links within a network and to the extent to which all the nodes of the network are accessible to each other (Janssen et al., 2006); networking capacity, which refers to the ability to create networks of non-identical elements or actors, connected by diverse interactions or links (Chuvarayan et al., 2006).

In an integrated smart and resilient system, the networking capacity regards also the capacity to connect computers and devices, since the information exchange increases the urban system persistence, supporting for example the real time mobilization of resources and services where they are needed.

The networking capacity is crucial also for the adaptability because it allows the creation of diverse network configurations.

Adaptability, generally related to the capacity of an urban system to adapt itself to unforeseen situations (Ratti and Townsend, 2011), can be improved through strategies and actions addressed to enhance: flexibility that, in opposition to hierarchical organizations, allows a system to be changed or adjusted to meet particular or changing needs; diversity that, recognized as crucial in case of impacts of adverse events, allows a system to better cope with uncertainty and surprise; a diverse economy ensures, for example that there is overall economic viability if one economic activity fails (Berkes et al. 2002); resourcefulness that refers to the availability of ecological, economic, social and cultural capital, allows the system to better cope with external pressures; modularity, which allows to recombine the elements of a system, supporting the transition towards different configurations; redundancy, which allows the system to count on superfluous/substitutable elements for adapting adaptable in the face of pressures; efficiency, that allows to reach optimal performances in the adapted configuration.

Finally, transformability that represents the capacity to create a fundamentally new system when ecological, political, social or economic conditions make the existing one untenable (Walker et al., 2004), can be improved through strategies and actions addressed to enhance: innovation in all elements and sectors of urban systems, from the physical to immaterial aspects, comprising the introduction of new methods, ideas, products or processes to achieve desirable outcomes (BSI, 2014); creativity, which generally results from research and experimentation that provide spurs for innovating cities in face of complex and unpredictable events; collaboration that allows to exchange new information and inputs and fosters creativity; resourcefulness, which refers to the ability to mobilize and use the available resources supporting the transition of the system towards new configurations; diversity, that allows elements to be separated and connected in new configurations.

As mentioned above, so far very few studies have attempted to combine a robust theoretical framework with operational tools.

The conceptual model - framing smart and resilient cities' characteristics along the different temporal stages that characterize the dynamic process for improving cities' capacity to deal with climate change and its impacts - provides a robust theoretical background for building up smart and resilient cities in the face of climate change.

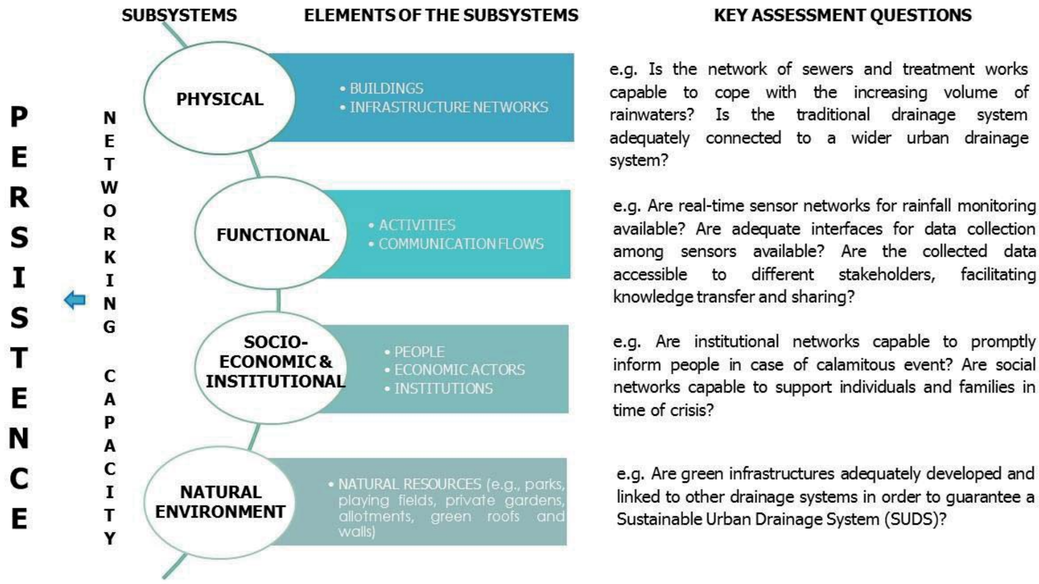


Fig. 8 Towards a guiding tool for evaluating the characteristics of a Smart and Resilient Urban System: an example related to the "networking capacity".

Nevertheless, an effective tool capable to guide planners and decision-makers in carrying out long, medium and short-term strategies addressed to pursue the key properties of a smart and resilient urban system in the face of climate change is still far to be achieved.

To bridge this gap, the next phase of the research work will be addressed to further develop the methodological path for guiding planners and decision makers in the assessment – with reference to the heterogeneous climate drivers and in respect to the different subsystems which constitute an urban system, physical, functional, socio-economic and institutional, natural environment (Papa et al., 2009) – of the different selected characteristics as well as in finding out the most appropriate strategies for enhancing them and monitoring their effectiveness.

An example may clarify what is meant here. According to the conceptual model, the persistence of the urban system in the face of intense rainfalls can be enhanced, by acting on different characteristics (robustness, reliability, connectivity, networking capacity, etc.). Hence, in the figure 8, an example of the methodological path for guiding planners and decision makers through the evaluation of the networking capacity of the different subsystems of an urban system, by using key assessment questions has been provided.

6 CONCLUSIONS

This study represents a first step of a wider research work addressed to develop conceptual and operational tools for improving cities' response in the face of the heterogeneous challenges posed by the climate-related phenomena. In detail, this contribution focuses on the metaphors of "smart" and "resilient" cities that, according to current scientific literature, seem to play a leading role in enhancing cities' capacities to cope with climate change. Based on the in-depth analysis of the current scientific literature in the field of both Smart City and Resilient City, this study has been firstly addressed to identify the main characteristics of a smart and resilient urban system. It has to be underlined that while in the resilience research field a large set of studies and researches have been focused on the characteristics of a resilient system, the Smart City literature does not provide in-depth studies on the characteristics of a smart urban system. However, some useful hints in this direction arise from the studies carried out by companies involved in the development of the Smart City standards (e.g., BIS, 2014) and from research works addressed to investigate Smart City performances (e.g., Coe, 2001; Giffinger et al., 2007; Lekamge and Marasinghe, 2013).

Then, the collected characteristics have been selected and framed into a conceptual model aimed at supporting the development of multi-objective strategies capable to improve the response capacities of complex urban systems in the face of climate change. The model is structured as a cyclical process, based on the learning capacity of urban systems and characterized by the "dynamic interplay of persistence, adaptability and transformability" (Folke et al., 2010); it outlines the temporal and operational phases that characterize the response of a complex urban system in the face of climate change, underlining roles and linkages of the different characteristics along this process, according to the different time spans (short-medium-long term). In detail, the model highlights that some characteristics (transformability) are crucial for supporting long-term strategies capable to reverse current urban development patterns in order to reduce GHG emissions and energy consumptions; others (persistence/adaptability) are relevant to short-medium term strategies aimed at enhancing cities' capacities to withstand or adapt to the heterogeneous climate-related impacts; others (such as learning) are at the base of the process, allowing the system to start, revise or change the strategies addressed to achieve the key properties of a smart and resilient city.

Although the conceptual model provides planners and decision-makers with a robust theoretical background for building up smart and resilient cities, it represents only a preliminary step for the development of an operational tool capable to guide them in carrying out multi-objective strategies addressed to enhance the response capacities of complex urban systems in the face of climate change.

To bridge this gap, the next step of this research work will be addressed to further develop the methodological path for guiding planners and decision-makers in evaluating – with reference to the heterogeneous climate drivers and in respect to the different subsystems which constitute an urban system – the characteristics of a smart and resilient urban system, as well as in finding out adequate strategies for enhancing them and monitoring their effectiveness.

ACKNOWLEDGEMENTS

The paper is part of a wider research work developed in the framework of the "SEM Project - Smart Energy Master for the energy management of territory", which aims at developing methods and tools for improving energy efficiency within high-density urban areas, as well as for dealing with climate change impacts and energy resources' scarcity, through an integrated strategy capable of improving smartness and resilience of urban areas.

REFERENCES

ABB (2012). Solid Foundations for Smart Cities. White paper. Available at:http://new.abb.com/docs/default-source/smart-grids-library/abb_smart_grids_white_paper_2013.pdf?sfvrsn=2.

ABB-Ambrosetti (2012). Smart Cities in Italia: un'opportunità nello spirito del Rinascimento per una nuova qualità della vita. Available at: http://www02.abb.com/db/db0003/db002698.nsf/0/0ea1c1498ed742dec1257a700032fbc8/$file/REPORT_ABBAmbrosetti_Completo.pdf.

ACCCRN (2012). ACCCRN City Projects Catalogue. Available at: http://www.acccrn.org/resources/documents-and-tools/2012/08/01/acccrn-city-projects-catalogue.

ACCCRN (2015). Resilience – an important aspect of Smart Cities. Available at: http://www.acccrn.org/news-and-events/entries/2015/01/06/resilience-%E2%80%93-important-aspect-smart-cities.

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, F. C., Rockström J. (2005). Social-Ecological Resilience to Coastal Disasters. Science 12 August 2005. Vol. 309 no. 5737 pp. 1036-1039. DOI: 10.1126/science.1112122.

Ahern, J. (2011). From fail-safe to safe-to-fail: sustainability and resilience in the new urban world. Landscape and Urban Planning, 100, 341-343

Alberti M., Marzluff J. M., Shulenberger E., Bradley G., Ryan C., Zumbrunnen C. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. BioScience 53:1169-1179.

Alexander, D.E. (2013), Resilience and disaster risk reduction: an etymological journey, Natural Hazards and Earth System Science, 13, 2707–2716. www.nat-hazards-earth-syst-sci.net/13/2707/2013/ doi:10.5194/nhess-13-2707-2013

Aoun, C. (2013). The Smart City Cornerstone: Urban Efficiency. Schneider Electric White Paper. Available at: http://www.digital21.gov.hk/sc/relatedDoc/download/2013/079%20SchneiderElectric%20%28Annex%29.pdf.

Auge Blùm, I., Boussetta, K., Rivano, H., Stanica, R., Valois, F. (2012). Capillary Networks: A Novel Networking Paradigm for Urban Environments. Proceedings of UrbaNE'12, December 10, 2012, Nice, France. Available at: http://conferences.sigcomm.org/co-next/2012/eproceedings/urbane/p25.pdf.

Bahadur, A. V., Ibrahim, M., Tanner, T. (2010). The resilience renaissance? Unpacking of resilience for tackling climate change and disasters. Strengthening Climate Resilience Discussion. Paper 1, Brighton: IDS. Available at: http://community.eldis.org/.59e0d267/resilience-renaissance.pdf.

Bankoff, G., Frerks, G., Hilhorst, D. (2004). Mapping vulnerability. Disasters, development and people. Earthscan, London.

Batty, M. (2008). Cities as Complex Systems. Scaling, Interactions, Networks, Dynamics and Urban Morphologies. Working Papers Series, Paper 131, Centre for Advanced Spatial Analysis, University College London, ISSN 1467-1298. http://discovery.ucl. ac.uk/15183/1/15183.pdf

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G., Portugali, Y. (2012). Smart City of the Future. The European Physical Journal - Special Topics 214, 481–518.

Bencardino, M., Greco, I. (2014). Smart Communities. Social Innovation at the Service of the Smart Cities. *TeMa, Journal of Land Use, Mobility and Environment*. Special Issue.

Berkes, F., Colding, J., Folke, C. (2003). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge.

Birkmann, J., Garschagen, M., Kraas, F. (2010). Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change. Sustainable Science 5(2):185-206. http://ihdp.unu.edu/file/get/10637.pdf.

Brand, F.S., Jax, K. (2007). Focusing the Meaning(s) of Resilience: Resilience as a Descriptive Concept and a Boundary Object. Ecology and Society 12(1): 23.

BSI (2013). Smart Cities: background paper. British Standards Institution. ISBN: 978 0 580 81874 5. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/246019/bis-13-1209-smart-cities-background-paper-digital.pdf.

BSI (2014). PAS 180, Smart cities – Vocabulary. British Standards Institution.

Brundtland Report (1987). Our common future. World Commission on Environment and Development (WCED). Oxford: Oxford University Press, 1987 p. 43.

Bruneau, M., Chang, S.E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, K., Wallace, W. A., von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. Earthquake Spectra, 19(4), 733–752.

Caragliu, A., Nijkamp, P. (2008). The impact of regional absorptive capacity on spatial knowledge spillovers. Tinbergen Institute Discussion Papers 08-119/3, Amsterdam: Tinbergen Institute.

Caragliu, A., Del Bo, C., Nijkamp, P. (2009). Smart cities in Europe. Proceedings of the 3rd Central European Conference in Regional Science (Košice, Slovak Republic, Oct 7-9). Available at: http://www.cers.tuke.sk/cers2009/PDF/01_03_Nijkamp.pdf.

Carpenter, S.R., Walker, B.H., Anderies, J.M. and Abel, N. (2001), From metaphor to measurement. Resilience of what to what? Ecosystems 4: 765-781.

Chelleri, L., Kunath, A., Minucci, G., Olazabal, M., Waters, J. J., Yumalogava, L. (2012). Multidisciplinary perspective on urban resilience. Workshop report. BC3, Basque Centre for Climate Change. ISBN: 978-84-695-6025-9. Available at: http://www.bc3research.org/multidisciplinary_perspectives_on_urban_resilience.

Chen, J., Chen, T. H. Y., Vertinsky, I., Yumagulova, L. and Park, C. (2013). Public–Private Partnerships for the Development of Disaster Resilient Communities. Journal of Contingencies and Crisis Management, 21: 130–143. doi: 10.1111/1468-5973.12021.

Chourabi, H., Taewoo Nam, Walker S., Gil-Garcia J.R. ; Mellouli S., Nahon K., Pardo, T.A., Scholl H. J. (2012). Understanding Smart Cities: An Integrative Framework. 45th Hawaii International Conference on System Sciences. 978-0-7695-4525-7/12 $26.00 © 2012 IEEE. DOI 10.1109/HICSS.2012.615.

Chuvarajan A., Martel I., Peterson C. (2006). A Strategic Approach for sustainability and resilience planning within municipalities. Thesis submitted for completion of Master of Strategic Leadership towards Sustainability, Blekinge Institute of Technology, Karlskrona, Sweden.

CIAT (2015). Report for Cities Impacts & Adaptation Tool. Climate Center, University of Michigan. Available at: http://graham-maps.miserver.it.umich.edu/ciat/report.xhtml.

Coe A., Paquet G., Roy J. (2001). E-Governance and Smart Communities: A Social Learning Challenge. Social Science Computer Review 2001; 19; 80.

Cohen, B. (2012). The top 10 smartest European cities. Available at: http://smartertrends.co.uk/articles/2012-11-14/the-top-10-smartesteuropeancities/original/?original=www.fastcoexist.com/1680856/the-top-10-smartest-european-cities

Colucci A. (2012). Le città resilienti: approcci e strategie. Monografia, Jean Monnet Centre of Pavia. Available at: http://www.jeanmonnet-pv.it/Jean_Monnet_Centre_of_Excellence/publications_files/full_txt_colucci_jm.pdf.

Cretu L. G. (2012). Smart Cities Design using Event-driven Paradigm and Semantic Web. Informatica Economică vol. 16, no. 4/2012. Available at: http://www.revistaie.ase.ro/content/64/07%20-%20Cretu.pdf.

Cutter S.L., Barnes L., Berry M., Burton C., Evans E., Tate E., Webb J. (2008), "A place-based model for understanding community resilience to natural disasters", Global Environmental Change, 18:598-606.

Dameri R. P. (2013). Searching for Smart City definition: a comprehensive proposal, International Journal of Computers & Technology. Vol 11, No.5. October 25, 2013. PP. 2544-2551.

Davoudi S. (2012). Resilience: A Bridging Concept or a Dead End?. Planning Theory and Practice 2012, 13(2), 299-307.

Davoudi S., Brooks E., Mehmood A. (2013), "Evolutionary Resilience and Strategies for Climate Adaptation", Planning Practice & Research, 28:3, 307-322. http://dx.doi.org/10. 1080/02697459.2013.787695

Da Silva J., Kernaghan S., Luque A. (2012). A systems approach to meeting the challenges of urban climate change. International Journal of Urban Sustainable Development, 4(2), 125–145.

Deakin M. (2012). Smart Cities: Governing, Modelling and Analysing the Transition. Routledge, 2012.

Dirks S., Gurdgiev C., Keeling, M. (2010). Smarter cities for smarter growth. How cities can optimize their systems for the talent-based economy. IBM Global Business Services. Executive Report.

Drobniak A. (2010). The Urban Resilience – Economic Perspective. Journal of Economics & Management. Vol. 10/2012. University od Economics in Katowice.

EEA (2012). Urban adaptation to climate change in Europe - Challenges and opportunities for cities together with supportive national and European policies. EEA Report No 2/2012. ISBN: 978-92-9213-308-5. Available at: http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change.

EEA (2014). Report of the EEA Scientific Committee Seminar on Environment, Human Health and Well-Being. Advancing the Knowledge Base. Summary of discussion at the European Environment Agency's Scientific Committee Seminar on 12 February 2014 in Copenhagen. Available at: http://www.eea.europa.eu/about-us/governance/scientificcommittee/reports/report-of-the-eea-scientific.

Eger J. M. (2009). Smart Growth, Smart Cities, and the Crisis at the Pump A Worldwide Phenomenon. I-WAYS - The Journal of E-Government Policy and Regulation. Volume 32 Issue 1, January 2009. Pages 47-53.

EIP - European Innovation Partnership on Smart Cities and Communities (2013). Available at: http://ec.europa.eu/energy/technology/initiatives/doc/2012_4701_smart_cities_en.pdf.

EIP - European Innovation Partnership on Smart Cities and Communities (2014). Available at: http://eu-smartcities.eu/content/show-world-you-are-smart-city.

Elmqvist, T. (2013). How Smart is a Smart City? Presentation at the Switched on Nature Seminar. Available at: http://www.stockholmresilience.org/5.2f48c3c31429b6ad0a61192.html.

ENSURE (2012). Integration of different vulnerabilities vs. Natural and Natech Hazards. Deliverable 2.2 of the Enhancing resilience of communities and territories facing natural and na-tech hazards Project.

Ercoskun, O.Y. (2012). A Paradigm Shift towards Urban Resilience. Green and Ecological Technologies for Urban Planning: Creating Smart Cities. IGI Global, 2012. 1-16. Web. 19 Jan. 2015. doi:10.4018/978-1-61350-453-6.ch001.

Ernstson, H., van der Leeuw, S., Redman, C.L., Meffert, D.J., Davis, G., Alfsen, C., Elmqvist, T. (2010). Urban transitions: on urban resilience and human-dominated ecosystems. AMBIO: A Journal of the Human Environment, pages 1–15.

EU (2009). Adapting to climate change: Towards a European framework for action. White Paper. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0147&from=EN.

EU (2011). Cities of tomorrow. Challenges, visions, ways forward. European Union, 2011. ISBN: 978-92-79-21307-6. doi:10.2776/41803. Available at: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/citiesoftomorrow/citiesoftomorrow_final.pdf.

EU (2013). An EU Strategy on adaptation to climate change. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0216&from=EN.

EU LIFE (2014). Urban Resilience - LIFE+ projects and European policies. 4-5 April 2014, Colombes, FR. Summary Report. Available at: http://ec.europa.eu/environment/life/news/newsarchive2014/documents/report-urbanresilience.pdf.

Fiksel, J. (2003). Designing resilient, sustainable systems. Environmental Science & Technology, 37(23), 5330–5339

Florida, R. (2003). Cities and the Creative Class. City and Communities. Volume 2, Issue 1, pages 3–19.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson L., Holling C.S., Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Ambio Vol. 31 No. 5.

Folke, C., Hahn, T., Olsson, P., Norberg, J. (2005). Adaptive Governance for Social-Ecological System. Annu. Rev. Environ. Resour. 30:441-73

Folke, C. (2006). Resilience: The Emergence of a Perspective for Social-Ecological Systems Analyses, in Global Environmental Change 16: 253–67.

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., Rockstrom, J. (2010) "Resilience Thinking: integrating Resilience, Adaptability and Transformability", Ecology and Society, 15(4):20. http://www.ecologyandsociety.org/vol15/iss4/art20/

Fusco Girard, L., Baycan, T., Nijkamp, P. (2012). The Creative City in a Multidimensional Perspective. Chapter of "Sustainable City and Creativity: Promoting Creative Urban Initiatives". Ashgate Publishing, Ltd.

Füssel, H.-M., Klein, R. J. T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. Climatic Change, 75(3), 301–329

Galderisi, A., Ferrara, F.F. (2012). Enhancing Urban Resilience In Face Of Climate Change, *TeMa, Journal of Land Use, Mobility and Environment*. Vol. 2, 69-87. DOI: 10.6092/1970-9870/936

Galderisi, A. (2013). Un modello interpretativo della resilienza urbana. PLANUM, the Journal of Urbanism. ISSN 1723-0993 | no. 27, vol. II [2013].

Galderisi, A. (2014). Climate Change Adaptation. Challenges and Opportunities for a Smart Urban Growth. *TeMa, Journal of Land Use, Mobility and Environm*ent. Vol.7, n.1.

Gibson, D.V., Kozmetsky, G., Smilor, R.W. (eds.) (1992), The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks, Rowman & Littlefield, New York.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., Meijers, E. (2007). Smart Cities: Ranking of European Medium-Sized Cities. Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology. Available at: http://www.smartcities.eu/download/smart_cities_final_report.pdf.

Glaeser, E.L., Berry, C.R. (2006). Why Are Smart Places Getting Smarter?. Taubman Cente Policy Brief 2006-2, Cambridge MA: Taubman Centre.

Godschalk, D.R. (2003). Urban Hazard Mitigation: Creating Resilient Cities. Natural Hazards Review, ASCE, August. DOI: 10.1061/~ASCE!1527-6988~2003!4:3~136!

Gunderson, L. (2010). Ecological and human community resilience in response to natural disasters. Ecology and Society 15(2): 18.

Hall, R. E. (2000). The vision of a smart city. In Proceedings of the 2nd International Life Extension Technology Workshop, Paris, France, September 28.

Hallegatte, S. (2009). Strategies to adapt to an uncertain climate change. Global Environmental Change 19 (2009) 240–247.

Heeks, R., Ospina, A. V. (2013). Understanding Urban Climate Change and Digital Infrastructure Interventions from a Resilience Perspective. Centre for Development Informatics. ISBN: 978-1-905469-77-2.

Heylighen, F. (2008), Complexity and Self-organization, in Bates M.J. and Maack N., eds., Encyclopedia of Library and Information Sciences, Taylor & Francis.

Hollands, R. G. (2008). Will the real smart city please stand up?. City: analysis of urban trends, culture, theory, policy, action. Volume 12, Issue 3, 2008. DOI: 10.1080/13604810802479126

Holling, C.S. (1973). Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4:1–23.

Holling, C.S. (1996), Engineering resilience versus Ecological resilience, in P. Schulze (ed.), Engineering with ecological constrains, National Academy, Washington, D.C., USA.

Hopkins, R. (2008). The transition handbook: from oil dependency to local resilience. Green Books, Totnes, Devon, UK. ISBN: 9781900322188

ICLEI (2014a). Available at: http://resilient-cities.iclei.org/resilient-cities-hub-site/resilience-resource-point/glossary-of-key-terms/.

ICLEI (2014b). How does the Urban NEXUS Approach and inter-sectoral coordination make cities more resilient? A.3. SESSION DESCRIPTION – 5TH Global Forum on Urban Resilience & Adaptation. Bonn, Germany 29-31 May 2014.

IFRC - International Federation of Red Cross and Red Crescent Society (2011). Characteristics of a Safe and Resilient Community. Community Based Disaster Risk Reduction Study. Available at: http://www.ifrc.org/ PageFiles/96986/Final_Characteristics_Report.pdf.

IPCC (2012), Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Cambridge University Press, Cambridge, UK, New York, USA. http://ipcc-wg2.gov/SREX/images /uploads/SREX-All_FINAL.pdf

IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. Available at: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

IPCC (2014). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

ISO/IEC (2014). Smart Cities. Preliminary Report 2014. ISO/IEC JTC 1, Information technology. Available at: http://www.iso.org/iso/smart_cities_report-jtc1.pdf.

ITU (2014). United Nations specialized agency for information and communication technologies – Focus Group on Smart Sustainable Cities. Available at: http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx.

Jabareen, Y. (2013). Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. Cities 31 (2013) 220–229.

Janssen, M. A., Bodin, Ö., Anderies, J. M., Elmqvist, T., Ernstson, H., McAllister, R. R. J., Olsson, P., Ryan, P. (2006). Toward a network perspective on the resilience of social-ecological systems. Ecology and Society 11(1): 15.

Jerneck, A., Olsson, L. (2008). Adaptation and the Poor: Development, Resilience and Transition. Climate Policy, 8(2): 170–82.

Kahan, J. H., Allen A. C., George, J. K. (2009). An operation framework for resilience. Journal of Homeland Security and Emergency Management. Volume 6, Issue 1. 2009. Article 83.

Kallaos J., Mainguy G., Wyckmans A. (2014). Considering Resilience: steps towards an assessment framework. *TeMa, Journal of Land Use, Mobility and Environment*. Vol.5, n.27.

Karnouskos S., Da Silva P. G., Ilic D. (2013). Energy Services for the Smart Grid City. Digital Ecosystems Technologies (DEST), 6th IEEE International Conference.

Klein R.J.T., Nicholls R.J., Thomalla F. (2003). Resilience to natural hazards: How useful is this concept? Global Environmental Change Part B: Environmental Hazards. Volume 5, Issues 1–2, 2003, Pages 35–45.

Klein, R.J.T., Schipper, E. L., Dessai, S. (2005). Integrating mitigation and adaptation into climate and development policy: three research questions. Environmental Science & Policy 8: 579–588. Available at: http://www.unisdr.org/files/1140_sdarticle.pdf.

Kramers A., Höjer M., Lövehagen N., Wangel J. (2014). Smart sustainable cities e Exploring ICT solutions for reduced energy use in cities. Environmental Modelling & Software.

Kuhn T.S. (1970). The Structure of Scientific Revolutions. International Encyclopedia of Unified Science, Foundations of the Unity of Science, Volume II, Number 2. Available at: http://projektintegracija.pravo.hr/_download/repository/Kuhn_Structure_of_Scientific_Revolutions.pdf.

Kunzmann K.R (2014). Smart Cities: A New Paradigm of Urban Development. Crios, 1/2014, pp. 9-20, doi: 10.7373/77140.

Lazaroiu G. C., Roscia M. (2012). Definition methodology for the smart cities model. Energy 47 (2012) 326-332. doi:10.1016/j.energy.2012.09.028.

Lee J.H., Phaal R., Lee S. H. (2013). An integrated service-device-technology roadmap for smart city development. Technological Forecasting and Social Change 80, 286–306. doi:10.1016/j.techfore.2012.09.020.

Lekamge S., Marasinghe A. (2013). Developing a Smart City Model that Ensures the Optimum Utilization of Existing Resources in Cities of All Sizes. Biometrics and Kansei Engineering (ICBAKE), 2013 International Conference, pp.202-207, 5-7 July 2013. doi: 10.1109/ICBAKE.2013.40.

Lombardi P. (2011). Managing the green IT agenda. Intelligent Buildings International Vol. 3, Iss. 1.

Longstaff P. H., Armstrong N. J., Keli P., Parker W. M., Hidek M. (2010). Building Resilient Communities - A Preliminary Framework for Assessment. Homeland Security Affairs, VI (3).

Low B., Ostrom E., Simon C., Wilson J. (2000). Redundancy and diversity in governing and managing common-pool resources. 8th Biennial conference of the International Association for the Study of Common Property (IASCP), Indiana University, Bloomington, Indiana, May 31-June 4, 2000.

Maguire B., Hagan P. (2007). Disasters and communities: Understanding social resilience. The Australian Journal of Emergency Management, Vol. 22 No. 2.

Martin-Breen P., Anderies J. M. (2011). Resilience: A Literature Review. Rockefeller Foundation Report. Available at: http://www.rockefellerfoundation.org/blog/resilience-literature-review.

McIntosh R.J., Tainter J. A., McIntosh S. K. (2000). The Way the Wind Blows: Climate, History and Human Action. Columbia University Press.

McMahon K. (2014). Smart Cities and Broadband. Broadband Communities. Available at: http://www.bbcmag.com/2014mags/Nov_Dec/BBC_Nov14_SmartCities.pdf.

Moccia F. D. (2012). Smart city: etimologia del termine. Un'analisi firmata INU. Available at: http://admin.edilio.it/smart-city-etimologia-del-termine-un-analisi-firmata-inu/p_19560.html.

Moir E., Moonen T., Clark G. (2014). What are future cities? Origins, meanings and uses. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/337549/14-820-what-are-future-cities.pdf.

Mosannenzadeh F., Vettorato D. (2014). Defining Smart City: a conceptual framework based on keyword analysis*. TeMa, Journal of Land Use, Mobility and Environment*. Special Issue.

Moser M. A. (2001). What is Smart about the Smart Communities Movement?. EJournal Volume 10-11 Number 1 (March 2001). Available at: http://www.ucalgary.ca/ejournal/archive/v10-11/v10-11n1Moser-print.html#SmartEconomicStrategies.

Moser C., Wendel T., Carabias-Hütter V. (2014). Scientific and Practical Understandings of Smart Cities. Proceedings REAL CORP 2014 Tagungsband 21-23 May 2014, Vienna, Austria.

Naphade M., Banavar G., Harrison C., Paraszczak J., Morris R. (2011). Smarter Cities and Their Innovation Challenges. 0018-9162/11/$26.00 © 2011 IEEE Computer Society.

Nam T., Pardo T. A. (2011). Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. The Proceedings of the 12th Annual International Conference on Digital Government Research. ACM, pp. 282–291.

Navarrete L. C., Dalmas S. ,Varas F. J., Fayos A., Busto F.J. (2012). Social Open Data to harness the empowerment of Smart Community. Available at: http://eu-smartcities.eu/sites/all/files/docs/best-practice/Social%20Open%20DAta%20to%20harness%20the%20empowerment%20of%20Smart%20Community%20.pdf

New City Foundation (2014).Beyond the Smart City: Towards a New Paradigm. Available at: http://www.newcitiesfoundation.org/.

Newman P., Beatley T., Boyer H. (2009). Resilient Cities: Responding to Peak Oil and Climate Change. Island Press, 2009. ISBN: 1597268631.

North P. (2010). Eco-localisation as a progressive response to peak oil and climate change – A sympathetic critique. Geoforum 41 (2010) 585–594.

Norris F., Stevens S., Pfefferbaum B., Wyche K., Pfefferbaum R. (2008), Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness, American Journal of Community Psychology, vol. 41.

Papa R., Battarra R., Calenda C., Cerrone D., Ceudech A., Fistola R., Galderisi A., Gargiulo C., La Rocca R.A., Mazzeo G., Papa E. (2009). Il governo delle trasformazioni urbane e territoriali. Metodi, tecniche e strumenti. Franco Angeli Editore, pp. 560. ISBN: 9788856811476.

Papa R., Galderisi A., Gargiulo C. (2013). Towards an Urban Planners' Perspective on Smart City. *TeMa, Journal of Land Use, Mobility and Environment*. Vol. 6, n.1.

Partridge H. (2004). Developing a Human Perspective to the Digital Divide in the Smart City. In Partridge, Helen (Ed.) Australian Library and Information Association Biennial Conference, 21-24 September 2004, Gold Coast, Queensland, Australia.

Paskaleva K. A. (2009). Enabling the smart city: the progress of city e-governance in Europe. International Journal of Innovation and Regional Development. Volume 1, Number 4/2009. Pages 405-422.

Pellegrini P. (2003). Smart Growth Movement, lo scenario emergente. Tesi di dottorato presentata nel giungno 2003. Pubblicata da Università IUAV di Venezia. IUAV Digital LIbrary © settembre 2011. ISBN 978-88-87697-59-9. Available at: http://rice.iuav.it/270/3/cap_2_smart_growth.pdf.

Pickett S.T.A., Cadenasso M.L., Grove J.M. (2004). Resilient cities: meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms. Landscape and Urban Planning 69 (2004) 369–384.

Pickett S.T.A., Boone C. G., McGrath B. P., Cadenasso M. L., Childers D. L., Ogden L. A., McHale M., Grove J. M. (2013). Ecological science and transformation to the sustainable city, Cities.

Ratti C., Townsend A. (2011). The Social Nexus. Scientific American, September 2011. Available at: http://senseable.mit.edu/papers/pdf/2011_Ratti_Townsend_Nexus_SA.pdf.

Redman C. L. (2014). Should sustainability and resilience be combined or remain distinct pursuits?. Ecology and Society 19(2): 37. http://dx.doi.org/10.5751/ES-06390-190237.

Resilient City (2014). Available at: http://www.resilientcity.org/index.cfm?id=11449.

Rose A. (2007). Economic resilience to natural and man-made disasters: multidisciplinary origins and contextual dimensions. Environmental Hazards, Volume 7, Issue 4, 2007, Pages 383-398, ISSN 1747-7891.

Roeckefeller Foundation (2014). Available at: http://www.rockefellerfoundation.org/our-work/current-work/resilience.

Rockefeller Foundation (2015). Available at: http://www.100resilientcities.org/cities#/-_/.

Rogers C. D. F., Bouch C.J., Williams S., Barber A.R.G., Baker C.J., Bryson J.R., Chapman D.N., Chapman L., Coaffee J., Jefferson, I. and Quinn A.D. (2012). Resistance and Resilience – two paradigms for critical local infrastructure. Proceedings of the ICE - Municipal Engineer, Volume 165, Issue 2, 01 June 2012 ,pages 73 –83.

Sapountzaki K. (2010). Vulnerability management by means of resilience. Natural Hazards: Journal of the International Society for the Prevention and Mitigation of Natural Hazards. ISSN 0921-030X. Nat Hazards. DOI 10.1007/s11069-011-9908-3

Schultz M. T., McKay S. K., Hales L. Z. (2012). The Quantification and Evolution of Resilience in Integrated Coastal Systems (No. ERDC TR-12-7). Washington, DC: U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC).

Simmie J., Martin R. (2010). The economic resilience of regions: towards an evolutionary approach. Cambridge Journal of Regions, Economy and Society 2010, 3, 27–43. doi:10.1093/cjres/rsp029

Smart City Council (2014a). Available at: http://smartcitiescouncil.com/article/next-decade-bring-fourfold-increase-number-smart-cities.

Smart Cities Council (2014b). Smart Cities Readiness Guide. Available at: http://smartcitiescouncil.com/resources/smart-cities-readiness-guide.

Sovacool B. K. (2011). Hard and soft paths for climate change adaptation. Climate Policy 11 (2011) 1177–1183. doi:10.1080/14693062.2011.579315.

Stacey R., Griffin D., Shaw P. (2000). Complexity and management: Fad or Radical Challenge to Systems Thinking? Routledge, London and New York.

STERIA (2011). Smart Cities will be enabled by Smart IT. Available at: http://www.steria.com/fileadmin/com/sharingOurViews/publications/files/STE3899-Smart_Cities_brochure_08_APP.PDF.

Stockholm Resilience Centre (2014). Applying resilience thinking. Seven principles for building resilience in social-ecological systems. Available at: http://www.stockholmresilience.org/21/research/research-news/4-22-2014-applying-resilience-thinking.html.

Suppe F. (1977). Elements of Scientific Theories: Concepts and Definitions, Chapter 2 of “The structure of scientific theories”, second edition.

Tasan-Kok T., van Kempen R., Raco M., Bolt G. (2013). Conceptual Overview of Resilience: history and context. Resilience Thinking in Urban Planning. GeoJournal Library 106. pp. 39-52.

Toppeta D. (2010). The Smart City vision: how innovation and ICT can build smart, "liveable", sustainable cities. THINK! REPORT 005/2010. Available at: http://www.inta-aivn.org/images/cc/Urbanism/background%20documents/Toppeta_Report_005_2010.pdf.

TURAS (2012). Urban Transformations: Integrating social-ecological resilience thinking into urban planning and governance. Transitioning towards urban resilience and sustainability project. Available at: http://www.turas-cities.org/uploads/biblio/document/file/213/WP3_Lit_Rev_Section_01_.pdf.

Tyler S., Moench S. (2012). A framework for urban climate resilience. Climate and Development. Vol. 4, No. 4, October 2012, 311–326

UN (2014). Population Division World Urbanization Prospects. The 2014 Revision, Highlights. Department of Economic and Social Affairs.

UNEP (2014). Climate Finance for Cities and Buildings - A Handbook for Local Governments. UNEP Division of Technology, Industry and Economics (DTIE), Paris. Available at: www.unep.org/publications.

UNISDR (2012a). Available at: http://www.unisdr.org/campaign/resilientcities/about.

UNISDR (2012b). How to make cities more resilient – A Handbook For Local Government Leaders. Available at: http://www.unisdr.org/we/inform/publications/26462.

Vale, L., Campanella, T.H. (2005). The resilient city: How modern cities recover from disaster. New York: OxFord University Press.

Viitanen, J., Kingston, R. (2014). Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. Environment and Planning A 2014, volume 46, pages 803 – 819. doi:10.1068/a46242

Wagener, W. (2008). Connected and Sustainable ICT Infrastructure. Cisco Internet Business Solutions Group. Report written specifically for Connected Urban Development Global Conference 2008—Amsterdam. Available at: http://www.cisco.com/web/about/ac79/docs/wp/ctd/connected_infra.pdf.

Walker, B., Holling C. S., Carpenter S. R., Kinzig A. (2004). Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5.

Walker B., Salt B. (2006), Resilience thinking: sustaining ecosystems and people in a changing world. Washington, DC: Island Press.

Washburn D., Sindhu U. (2011). Helping CIOs Understand "Smart City" Initiatives. Defining The Smart City, Its Drivers, And The Role Of The CIO. Forrester Research Report. Available at: http://www.itworldcanada.com/archive/Themes/Hubs/Brainstorm/forrester_help_cios_smart_city.pdf.

Wolfram M. (2012). Deconstructing Smart Cities: An Intertextual Reading of Concepts and Practices for Integrated Urban and ICT Development. Proceedings REAL CORP 2012 Tagungsband 14-16 May 2012, Schwechat.

World Bank Group (2011). Guide to Climate Change Adaptation in Cities. Available at: http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1318995974398/GuideClimChangeAdaptCities.pdf.

Zani B. (2012). Empowerment: analisi di un costrutto "intrigante", in: Psicologia di Comunità. Prospettive, Idee, Metodi. ROMA, CAROCCI, 2012, pp. 135 – 162.

IMAGE SOURCES

Cover image: http://pixabay.com/en/rotterdam-erasmus-bridge-stadt-269281/
Fig. 1, 5, 6, 7, 8: figures are from authors
Fig. 2, 3, 4: figures are from Google Trends

AUTHORS' PROFILES

Rocco Papa

Full Professor of Land Use Planning at the University of Naples Federico II. Editor-in-Chief of the Scientific Journal TeMA - Land Use, Mobility and Environment since 2007. Director of the Department of Urban and Regional Planning (DiPiST) of the University Federico II of Naples, from 1999 to 2005. Chairman of the Urban Transformation Company Bagnolifutura S.p.A from 2006 to 2010. Vice-Mayor of the Municipality of Naples, from 2001 to 2006.

City Councilor for Livability (appointed to Town Planning and Historical Centre) for the Naples Municipality, from 1997 to 2001. Research activity, carried out continuously since 1974, has developed according to the following four main lines: the study of the interactions between urban and mobility systems; the management and governance of metropolitan areas; the safeguard of environmental quality in highly urbanized areas; the experimentation of new protocols for urban planning tools connected with the updating of techniques, methods and models of analyses, interpretation, planning and governance of territory. As City Councilor for Livability (appointed to Town Planning and Historical Centre) for the Naples Municipality he has developed in detail the following projects: the approval and implementation of the new Master Plan of Naples; the approval and implementation of the Local Master Plan for the area of Bagnoli-Coroglio and the establishment of the Urban Transformation Company Bagnolifutura SpA, and the restoration and requalification of the "Real Albergo dei Poveri" and of the "SS. Trinità delle Monache", the implementation of the Line 1 and Line 6 of the Metropolitan Railway. He is the author of more than 100 publications.

Adriana Galderisi

Assistant Professor at the Department of Civil, Architectural and Environmental Engineering - University of Naples Federico II. Ph.D. in Urban and Regional Planning; Professor of Urban and Regional Planning at the University of Naples Federico II. Research activities are mainly focused on the urban environment requalification and namely on two issues: the relationships between land use planning, mobility and environmental issues; vulnerability and resilience of urban systems to natural and na-tech events. In respect to the latter, she has coordinated research teams within numerous National and European Projects from 2000 to 2008. From 2008 to 2011, she has been the Scientific Responsible for the European Project "ENSURE - Enhancing resilience of communities and territories facing natural and na-tech hazards" (7° Framework Programme - Theme 6 Environment - Topic 6.1.3.2.1 Frame for better vulnerability assessment). From 2012, she is the Responsible for the Training Project of the National Project "Smart Energy Master for the energy management of territory" (PON 04A2_00120 R&C Axis II). She is author of more than 80 publications (monographs, chapters in books and articles).

Maria Cristina Vigo Majello

Architect (2003), Master in Building and Environmental Design for Photovoltaics Integration (2004), PhD in Architectural Design (2007), PhD in Building and Environmental Recovery (2013) at the Department of Architecture, University of Naples Federico II. She has collaborated in the research activities of the Department of Architecture, University of Naples Federico II, with the Corited Consortium, developing skills on national and international research projects on sustainable energy related to existing built environment (2009-2011). Research activities have been focused on renewable energies, innovative technologies and integrated management models to promote energy efficiency of existing built environment. In 2014, she won a one-year grant for post-lauream education and research within the project "Smart Energy Master" at the Department of Civil Engineering, Building and Environmental Engineering, University of Naples Federico II.

Erika Saretta

Civil Engineer graduated at the University of Padua presenting a dissertation "Photovoltaics and Net Zero Energy Buildings: new concepts towards a Smart City vision", carried out in collaboration with ENEA. In 2014, she won a one-year grant for post-lauream education and research within the project "Smart Energy Master" at the Department of Civil Engineering, Building and Environmental Engineering, University of Naples Federico II.

TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2015) 51-68
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2918

review paper received 29 January 2015, accepted 24 April 2015

www.tema.unina.it

How to cite item in APA format:
Hartmann, T. & Spit, T. (2015). Implementing European climate adaptation policy. How local policymakers react to European policy. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 51-68. doi: http://dx.doi.org/10.6092/1970-9870/2918

IMPLEMENTING EUROPEAN CLIMATE ADAPTATION POLICY

HOW LOCAL POLICYMAKERS REACT TO EUROPEAN POLICY

THOMAS HARTMANN[a], TEJO SPIT[b]

[a,b] Urban and Regional Research Centre, Utrecht University,
e-mail: [a]t.hartmann@uu.nl, [b]t.j.m.spit@uu.nl
URL:[a]www.uu.nl/staff/THartmann, [b]www.uu.nl/staff/TJMSpit

ABSTRACT

EU policy and projects have an increasing influence on policymaking for climate adaptation. This is especially evident in the development of new climate adaptation policies in transnational city networks. Until now, climate adaptation literature has paid little attention to the influence that these EU networks have on the adaptive capacity in cities. This paper uses two Dutch cities as an empirical base to evaluate the influence of two EU climate adaptation projects on both the experience of local public officials and the adaptive capacity in the respective cities.
The main conclusion is that EU climate adaptation projects do not automatically lead to an increased adaptive capacity in the cities involved. This is due to the political opportunistic use of EU funding, which hampers the implementation of climate adaptation policies. Furthermore, these EU projects draw attention away from local network building focused on the development and implementation of climate adaptation policies. These factors have a negative cumulative impact on the performance of these transnational policy networks at the adaptive capacity level in the cities involved.
Therefore, in order to strengthen the adaptive capacity in today's European cities, a context-specific, integrative approach in urban planning is needed at all spatial levels. Hence, policy entrepreneurs should aim to create linkage between the issues in the transnational city network and the concerns in local politics and local networks.

KEYWORDS:
climate adaptation, EU, transnational city networks, Netherlands, adaptive capacity

TeMA

有关土地使用、交通和环境的杂志

TeMA 1 (2015) 51-68
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2918

review paper received 29 January 2015, accepted 24 April 2015

www.tema.unina.it

How to cite item in APA format:
Hartmann, T. & Spit, T. (2015). Implementing European climate adaptation policy. How local policymakers react to European policy. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 51-68. doi: http://dx.doi.org/10.6092/1970-9870/2918

实施欧洲气候适应性政策

地方政策制定者如何响应欧洲政策

THOMAS HARTMANN[a], TEJO SPIT[b]

[a,b] Urban and Regional Research Centre, Utrecht University,
e-mail: [a]t.hartmann@uu.nl, [b]t.j.m.spit@uu.nl
URL:[a]www.uu.nl/staff/THartmann, [b]www.uu.nl/staff/TJMSpit

摘要

欧盟政策与项目对于气候适应性决策的影响越来越大。这在跨国城市网络气候适应新政策的制定过程中最为明显。截至目前，关于这些欧盟网络对于城市适应能力的影响，气候适应性文献仍关注甚少。本文将荷兰的两座城市作为实证基础，评估两个欧盟气候适应性项目对于两个城市当地政府官员的经验和适应能力分别产生的影响。
主要结论是：欧盟气候适应性项目并不能自动提高有关城市的适应能力。这是由于在政治上投机使用欧盟所提供的经费，阻碍了气候适应性政策的实施。此外，这些欧盟项目使人们把注意力从当地专注于气候适应性政策制定与实施的网络建设上转移开来。这些因素对于有关城市跨国政策网络的适应能力水平造成负面的累积影响。
因此，为了增强今天欧洲城市的适应能力，各级空间都需要在城市规划中采用情景特定的综合方法。因此，政策制定者应努力创建关联，联结起跨国城市网络中的事项与当地政治及网络中的关注点。

关键词
气候适应，欧盟，跨国城市网络，
荷兰，适应能力

1 INTRODUCTION

Climate adaptation in cities is a new and major urban challenge for the 21st century (Hunt & Watkiss, 2007; Kamal-Chaoui & Robert, 2007). The Netherlands are particularly vulnerable to climate change because they are located in a delta area. Rising sea levels and changing precipitation patterns, as expected by the IPCC (2014), threaten Dutch cities (PBL, 2011). Like many other European countries (Biesbroek et al., 2009), the Netherlands adopted a National Adaptation Strategy, entitled 'Maak ruimte voor klimaat!' (Make space for climate!) (VROM, 2007), as well as a Delta-programme (2008).

However, when compared with other European countries, the involvement of the Dutch central government in climate adaptation is relatively low (Biesbroek et al., 2011). The Netherlands are a decentralised unitary state in which local authorities are responsible for implementing national adaptation policies in their cities.

But, in most Dutch cities, climate adaptation in urban planning is (still) not evident. Usually, only fragmented projects are realized, such as funding green roofs or disconnecting rainwater from the sewer system (VROM, 2010). Policy entrepreneurs (Huitema and Meijerink, 2010) in urban planning have a key role in initiating and facilitating the adaptive capacity for cities (Adger et al., 2007; Blanco et al., 2009; De Bruin et al., 2009) because they have a more long-term policy perspective, which is necessary for responding to long-term climate change. However, lack of awareness and diverging perceptions about the risks of climate change limit the adaptive capacity (Adger et al., 2009; Hartmann & Spit, 2014).

The European Union has recognised the importance of climate adaptation for its Member States (CEC, 2007, 2009). A Green Paper on climate change adaptation (CEC, 2007) outlined the main impacts of climate change in Europe and formulated an adaptation strategy.

It included adaptation in all the EU's activities as well the development of an adaptation research programme at the EU level and the involvement of other stakeholders.

The related White Paper (CEC, 2009) stressed the coordinating role of European institutions in (trans-border) national climate adaptation (Dumollard & Leseur, 2011). The latest framework focused on the following key areas:

- Building a stronger knowledge base;
- Taking climate change impacts into consideration in key EU policies;
- Financing climate change policy measures;
- Supporting wider international efforts toward adaptation.

In addition to this framework, the European Commission has launched several EU projects to promote climate adaptation. Two examples of recently completed projects with Dutch case studies are GRaBS (Green and Blue Space adaptation for urban areas and eco-towns) and the INTERREG IVB project, or 'FUTURE CITIES'.

The objectives of these two projects are comparable; both are city networks for climate adaptation. GRaBS (www.grabs-eu.org) focused on building transnational policy networks through knowledge exchange and the transfer of best practices in order to achieve policy change by integrating climate change adaptation in regional and urban planning, notably green and blue infrastructures (Holstein & Schwaberger, 2011).

FUTURE CITIES aimed to build urban networks between city regions in northwest Europe that are facing climate change. It focused on the strategic components of green structures, water systems and energy efficiency in order to achieve synergic outcomes in existing urban structures (www.future-cities.eu).

Academic literature has paid little attention to the influence of such transnational projects on local climate adaptation policies. The debate on responses to climate change focused for a long time on mitigation (Galderisi, 2014). The recent scholarly debate on resilience brings attention to climate adaption (Colucci 2012). Adaptation encompasses measures that adjust natural or human systems in response to expected climate change induced effects (Galderisi et al. 2012).

Besides, the implementation of such climate adaptation has often been studied in terms of the performance of *national* (spatial) policies on a regional and local scale (Papa, 2012; De Lange et al., 1997; Mastop, 1997).

This paper focuses instead on the performance of *EU* climate adaptation *projects* at a local level. It has been ascertained in previous research that the local level is crucial for climate adaptation (i.e. resilience) (Pinto, 2014). So, it discusses the tension between the micro and macro level of climate adaptation.

We investigate if the cooperation in EU transnational city networks may create new opportunities for policy entrepreneurs in cities to promote climate change policy through knowledge exchange and access to EU funding. In other words, do European projects work as a strategy to implement climate adaptation on a local level? Thereby, the assumption if transnational city networks are indeed necessary for implementing climate adaptation is not questioned.

There are good arguments for such city networks for climate adaptation. First of all, climate adaptation is a topic that requires mutual learning, because it is a relatively new topic for local policymakers. Also, such networks can provide a basis for disseminating experiences and ideas across them.

This is important for the implementation of a transnational policy that requires implementation on the local level. However, this paper does not focus on the analysis of the content of the policy, but rather the process: how are the European objectives pursued in the projects.

So this is about the implementation of transnational objectives on the local level. The EU FUTURE CITIES and GRaBS projects have been in progress for several years.

Therefore, if the EU projects have had a significant effect on enhancing the adaptive capacity of the (Dutch) cities involved, it should be recognizable by now. However, our analysis suggests that EU climate adaptation projects do not, in fact, automatically lead to an increased adaptive capacity in the project areas.

These transnational policy networks have intrinsic limitations; additionally, there are interfering factors that affect the performance of these networks.

We expect these project examples to be similar to policy developments elsewhere in Europe. Researching the performance and effects of such projects on the local adaptive capacity can provide deeper insight into the transnational governance processes.

For the purpose of this paper, the case study areas are as follows: the Amsterdam Nieuw-West Borough was selected for its involvement in the EU GRaBS network; and the municipality of Nijmegen was selected for its collaboration together with the cities of Arnhem and Tiel in the FUTURE CITIES network. The central questions of this paper are:

- To what extent can EU climate adaptation projects increase the adaptive capacity of (Dutch) cities?
- What other interfering factors affect the results?
- What lessons can be learned for other European cities?

We used a reflexive approach to evaluate the performance of these EU projects at the adaptive capacity level of the cities involved. This implies that we not only evaluate whether the formal policy goals have been achieved, but also include interfering factors and the claims, concerns, and issues identified by local policymakers (Huitema et al., 2011).

From 2011 to 2012 we conducted in-depth interviews with seven Dutch local public officials to elicit their perceptions of the effectiveness of the EU climate adaptation projects.

On average, the interviews lasted one and a half hours. They were later recorded and transcribed in full. These interviews were treated as general findings because they reflect the overall sentiment in similar municipal contexts. In the first section of this paper, in order to place the two case studies in context, we first outline climate adaptation governance theory and policy theory as our theoretical framework. This section identifies the critical factors that would increase the adaptive capacity in cities.

These factors provide a backdrop for the next two sections: our empirical analysis of and evidence for the EU GRaBS project in the Amsterdam Nieuw-West Borough and the EU FUTURE CITIES project in the city of Nijmegen. We discuss the results and conclusions in the final section and indicate how they will contribute to the broader international debate on transnational policy networks.

2 CLIMATE ADAPTATION GOVERNANCE, POLICY NETWORKS AND POLICY CHANGE

2.1 THE GOVERNANCE OF CLIMATE ADAPTATION

Climate adaptation encompasses all measures that reduce vulnerability to the impact of climate change (Adger et al., 2007). Such measures include altering the exposure of the urban elements to the effects of climate change or increasing the resilience of social and ecological systems in cities. The adaptive capacity is the ability of individuals, groups or organisations to implement such adaptation measures (Adger et al., 2005, p. 78). To achieve climate adaptation, a broad range of actors (heterogeneity of actors) needs to collaborate, ranging from local government, to housing associations, property developers and residents (Carter, 2011; Füssel, 2007). In addition to local government, many other stakeholders control crucial resources, such as land, money, real estate and local knowledge and they need to be coordinated (integrative policies). Local government must therefore negotiate with these stakeholders and engage them in climate adaptation processes (Runhaar et al., 2009). Successful adaptation depends on the distribution of the adaptive capacity across all stakeholders (Adger et al., 2005; Adger, 2010).

The stakeholders' action toward climate adaptation requires integrated adjustments in behaviour as well as in resources and technologies (Adger et al., 2007). For this reason, isolated or sectoral solutions are not sufficient for successful climate adaptation. Integrative policies are needed to precipitate adaptation (Adger et al., 2005; Biesbroek et al., 2011; Füssel, 2007). Isolated or sectoral solutions can be most efficient in itself (Witte & Spit 2014). Furthermore, climate adaptation needs to be tailored to the specifics of every local situation (location specific measures and context specific processes) (see Adger et al., 2005; Nelson et al., 2007). Urban planning is most well-suited for the job, as it combines a long-term perspective with the ambition to integrate all types of policy with spatial effects.

The implementation of climate adaptation on a local level is a complex process. It seeks to combine many different stakeholders and policy networks and to align a large diversity of normative views (March & Olsen, 1976; van Buuren et al., 2007). Mees and Driessen (2011) used case studies in various countries (London, Rotterdam and Toronto) to illustrate that institutional fragmentation and compartmentalisation are barriers to the implementation of climate adaptation (policy fragmentation). Furthermore, awareness (Uittenbroek 2014) and coherence of the possible impacts of current extreme weather events and long-term climate change (temporal scaling) play a crucial role in implementation processes, because it leads to a sense of urgency (sens of urgency) (Hartmann & Spit 2014). Differences between climate developments and policy processes (climate change is long-term, many policy issues are short-term) are another important barrier to climate adaptation (conflicting timescales). The consequence is a lack of political priorities, ultimately leading to a low priority designation for climate adaptation (political will) (Biesbroek et al., 2011; Lorenzoni et al., 2007).

To summarise, the critical success factors for climate adaptation governance are the heterogeneity of the actors involved, integrative policies, and context- and location-specific processes and adaptation measures. The critical fail factors are policy fragmentation, a lack of sense of urgency, conflicting time scales and political will in decision-making. All these factors can interfere with the performance of the EU projects at the adaptive capacity level in the cities involved. This leads to a key question: Can climate adaptation be achieved via transnational city networks aimed at enhancing the cities' adaptive capacity?

2.2. POLICY NETWORKS AND POLICY CHANGE

Disasters and other shock events are the most important triggers to policy change (Birkland, 1998; Hartmann & Needham, 2012). However, most policy changes occur slowly because, according to Lindblom's incrementalism (1959), policies emerge as (political) compromises. Making small steps but keeping a clear vision of the ultimate goal may prove to be a better strategy for policymakers than dramatic policy change without societal or political acceptance (Mintrom & Norman, 2009). This incremental approach is a common strategy in spatial planning (Hartmann, 2012; Hartmann & Spit, 2012).

Thus, most public policy is characterised by continuity or incremental change, as is demonstrated in an advocacy coalition framework (Sabatier & Jenkins-Smith, 1993). These coalitions or policy networks (Koppenjan & Klijn, 2004) share policy core beliefs, norms and values. Consequently, the policy of the network is more resistant to change. Klijn and Koppenjan (2000: 19) define policy networks as 'a (more or less) stable pattern of social relations between interdependent actors, which take shape around policy problems and/or policy programmes.' Policy networks, which are very closed, are largely insensitive to the multiple contexts around them and are not open to policy change, whereas adaptive policy networks are sensitive and adaptive to their environment and can generate policy change (Teisman et al., 2009).

Policy changes can be triggered by policy entrepreneurs (Huitema & Meierink, 2010). Policy entrepreneurs are individuals or small groups inside or outside a governmental organisation who enable policy change. Generally, they possess four broad competences: maintaining social sensitivity; defining problems by highlighting the shortcomings of current policies; drawing greater support by building teams and making use of their broad professional networks; and working with coalitions to promote policy change. If they are involved in pilot projects, they can influence risk perceptions leading to policy change and build momentum for that change. Such change can be most successful when policymakers operate as 'boundary spanners' in policy networks and across separate policy domains (Mintrom & Norman, 2009; Teisman et al., 2009).

We might expect in our case studies that policymakers will operate as policy entrepreneurs, achieving policy change through effective use of the networks. Because cities suffer increasingly from limited financial means, and because climate adaptation has a relatively low political priority, a strategy to search for links with existing or planned initiatives could strengthen the adaptive capacity in cities (Carter, 2011). In other words, fostering goal intertwinement between various policy networks might bind actors together, creating opportunities to share costs so that new solutions can emerge (Koppenjan & Klijn, 2004).

The EU has promoted transnational policy networks. These networks are characterised by a high dependence on the policy sector, depoliticised policymaking, the dependence of supranational agencies on other agencies to deliver a service, and the pursuit of aggregating interests (CEC, 2007; 2009). However, transnational policy networks may also affect the cities' room to manoeuvre (Rhodes, 2000). This can be a hindrance to context- and location-specific climate adaptation. In addition, depoliticised policymaking can restrict local political support (Biesbroek et al., 2011). European cities are increasingly involved in transnational policy networks (Heinelt & Niederhafner, 2008; Kokx & Van Kempen, 2010). They cooperate transnationally in order to develop common policies and gain access to EU project funding. In such networks, cities act autonomously and voluntarily. The networks are a form of polycentric, horizontal, and non-hierarchical self-governance; decisions within the network are directly implemented by its members. Members of the networks can be local governments, scientific institutions, businesses, NGOs and individuals (Keiner & Kim, 2007). In the case of the EU, transnational city networks enhance its governing capacity to implement its policies without requiring it to engage with the nation states. Policy entrepreneurs that mediate between the transnational city network and local policy networks have the potential to achieve the most successful policy change and political support.

However, transnational city networks are increasingly focused on only one policy field (Kern & Bulkeley, 2009). This can be a hindrance to an integrative approach to climate adaptation because it promotes the maintenance of entrenched sectoral policy communities (Keiner & Kim, 2007), whereas effective climate adaptation requires both integrated solutions and heterogeneity of governance networks (Adger, 2010; Adger et al., 2005; Biesbroek et al., 2010; Füssel, 2007). To summarise, the success factors of these transnational policy or city networks are the learning and linking of these networks with heterogeneous local networks and local politics. The fail factors are depoliticised policymaking, a lack of discretion, a sectoral focus, and the neglect of the local context. Together, these success and fail factors provide a backdrop for our analysis of the performance of EU climate adaptation projects at the adaptive capacity level of the selected Dutch cities.

3. THE PROJECT GRABS

Municipalities, provinces, universities and non-profit organisations from eight different countries collaborated in the EU project GRaBS (2008–2011). This project aimed at exchanging knowledge and experiences to provide decision makers, politicians, communities and planners across Europe better information on urban adaptation challenges and appropriate measures to accommodate climate change impacts (Holstein and Schwaberger, 2011). We will discuss the case study of Amsterdam's Nieuw-West Borough. The neighbourhood, numbering about 138,000 inhabitants (2011), is characterized by its many ethnic minorities, its below-average personal income levels, and its own elected council and Executive Board.

The four main objectives of GRaBS were:

- To raise awareness and increase the expertise of professionals in spatial planning to adapt to projected climate scenarios;
- To develop adaptation action plans to coordinate the delivery of urban greening and adaptation strategies;
- To develop a risk and vulnerability assessment tool to help strategic planners with climate change adaptation responses;
- To improve stakeholders and community understanding and involvement in planning, based on positive community involvement techniques.

3.1. MOTIVATION TO PARTICIPATE IN GRABS

Engagement in transnational policy networks reflects a political sense of urgency to achieve climate adaptation (Biesbroek et al., 2011). According to the GRaBS local public manager in Amsterdam, the most important reason for partners to participate in GRaBS was that it provided the best opportunity to become collectively involved again. However, climate adaptation appeared to not be an important political issue at the local level (Biesbroek et al., 2011), as a senior environmental civil servant in Amsterdam illustrated: 'Of course, the borough has environmental and sustainability priorities, but when we decided to start the project, climate adaptation policy was definitely not a spearhead within these policies.' (Local Public Manager, Amsterdam).

Moreover, public officials in Amsterdam saw it merely as an opportunity to create a link with protecting green spaces. Consequently, climate adaptation was not the driving force behind participation in the project, but it was used as a means to link to other networks and to local public officials' own strategies. This illustrates an opportunistic motivation to get involved in these transnational city networks.

3.2 INCREASED AWARENESS OF PROFESSIONALS

According to public officials involved in the Amsterdam case, GRaBS led to an increased internal awareness for urban planners and green design professionals because a direct link had been made between climate adaptation and the preservation of the green spaces. 'It could also have been another relation, but coincidentally this sentiment is very strong here and very many people, especially urban and green designers, are keen on it' (public official, Amsterdam).

Another public official (Amsterdam) stressed that climate adaption had offered new challenges to professionals in urban planning: 'It isn't that the task is radically different now, but it offers them new perspectives for doing things in spatial policies that they have done in the past' (public official, Amsterdam).

This illustrates the incremental change of climate adaptation policies (Lindblom, 1959) wherein knowledge from the transnational policy network can be an inspiration for other local policy makers (Dolowitz & Marsh, 2000).

3.3 CLIMATE ADAPTATION ACTION PLAN

During the second and third year of the project, the local focus was primarily on the development of the climate action plan. According to the public officials, urgent climate-related problems were not a trigger for developing this plan. Rather, it was a requirement of the GRaBS partnership, and therefore the initial focus was on pilot projects to implement existing knowledge: 'That was also our goal at the start of GRaBS: We must have some pilot projects. We are not developing new knowledge, but are applying existing knowledge. At a certain point in the process, the partners were all obliged to organise their projects and procedures in exactly the same way" (GRaBS manager, Amsterdam).

This quote illustrates the coercive character of the transnational city network (Dolowitz & Marsh, 2000; Rhodes, 2000) by virtue of the fact that it required similar procedures and deliverables (Kern and Bulkely, 2009) in order to aggregate interests (Rhodes, 2000). This case also reveals that different cities can have very different perceptions (March & Olsen, 1976) about the most effective way to increase their adaptive capacity. Therefore, cities in this transnational city network are less autonomous than one may expect (Keiner & Kim, 2007).

Furthermore, the aim of GRaBS was that the climate adaption plan would serve as one of the leading concepts in future urban planning in order to achieve policy change. Every spatial plan must now include a paragraph on climate and address climate adaptation policy. This promotes only a sectoral focus on climate adaptation, whereas real policy integration might offer more opportunities to increase the adaptive capacity (Adger et al., 2005; Biesbroek et al., 2011; Füssel, 2007). Additionally, according to the same official in Amsterdam, the climate adaptation plan offers no guarantee of effective climate adaptation in the future, as the adaptation plan, due to lack of real political will, may only be used as 'window dressing' (Biesbroek et al., 2011).

According to the manager of the urban design department (Amsterdam), the spatial project managers, in particular, are not very enthusiastic about climate-proof neighbourhoods because they immediately suspect that costs will run up. In general, policy makers involved in the transnational policy network achieve little or no professional support for climate adaptation in other policy domains. (Mintrom & Norman, 2009; Kern & Bulkeley, 2009). There is also the risk that a lack of urgency will lead to diminishing interest in climate adaptation in the future, as the GRaBS manager (Amsterdam) pointed out: 'I think this is a major risk. The project is coming to an end and there is a real risk that the momentum behind the project will diminish once it's finished. There is always the risk that interest will disappear completely, due to a lack of a sense of urgency in the borough' (GRaBS manager, Amsterdam).

So we see that the urgency of climate change was not the main trigger behind the development of the climate action plan, rather, it was drawn up to meet a formal requirement of the GRaBS project (Kern & Bulkeley, 2009; Keiner & Kim, 2007; Dolowitz & March, 2000; Rhodes, 2000). The public officials' initial aim to start with pilot projects, in order to build momentum for policy change (Mintrom & Norman, 2009; Huiteman & Meierink, 2010), vanished, and the climate adaptation plan did not guarantee that adaptation would take place in the future. This was due to a lack of intrinsic political motivation, which hampered real policy change towards climate adaptation (Briesbroek et al., 2011). However, the outcome could have been different if local policy entrepreneurs from the transnational policy network had operated as real boundary spanners between separate policy domains and local politics (Mintrom & Norman, 2009; Kern & Bulkeley, 2009). Unfortunately, the focus on the timely completion of (sectoral) requirements within the EU project limited this opportunity.

3.4 ASSESSMENT TOOL

One of the requirements of the GRaBS project was implementing a local risk and vulnerability assessment tool. The tool was based on a Geographical Information System (GIS). The main aim was to assess current vulnerability, with an additional assessment of relative spatial patterns of risk, in order to develop appropriate policies and guidelines to include in the local adaptation action plans. However, the public officials from Amsterdam who were involved described difficulties in using the tool. These difficulties arose from obtaining the correct input data from the various fragmented departments in the city authority. As a result, the usefulness of the assessment tool was questionable: 'GRaBS has made a toolbox. But, here and there I have my doubts about it. How useful is it? I don't think it has enough information to help us, especially us designers. I can't use it as a design tool' (manager of the urban design department from Amsterdam).

In the end, local public officials from Amsterdam used another existing tool, which was originally designed for environmental and water policies. Overall, the GRaBS project has not led to increased knowledge on climate effects: 'As far as the supposedly enormous increase in knowledge on climate effects at a borough level over the three years of the GRaBS project is concerned, to be honest, I don't believe this to be the case. However, if you want to be specific, then you have to address the issue of causality. It is therefore hard to assess the effectiveness of climate adaptation policy' (GRaBS manager, Amsterdam).

An accurate, context-specific (Adger et al., 2005; Nelson et al., 2007) assessment tool at a borough level is difficult to develop even in practice. Thus, the transnational policy network is seriously limited in developing context-specific knowledge (Dolowitz & Marsh, 2000). This hard evidence would be necessary to raise climate adaptation on the political agenda. In consequence, the effectiveness of the tool for increasing local adaptive capacity is restricted. When compared to the use of similar tools planning and policy making, they meet similar critics (Vonk et al. 2007). Van Stigt (et al. 2015) recommend to use a user perspective in order to overcome context specificity and create a demand for such knowledge.

3.5 STAKEHOLDER AND COMMUNITY INVOLVEMENT

One of the aims of the GRaBS project was to enhance adaptive capacity through network building (Adger et al., 2005; Füssel, 2007; Runhaar et al., 2009; Carter, 2011). According to the GRaBS manager from Amsterdam, this was their most important objective, namely, to develop a network of residents and stakeholders. During the first year of the project, greater attention was paid to the knowledge exchange between international partners on community participation. Therefore, resident participation was limited and not focused on increasing residents' adaptive capacity (Adger er al., 2007). Later in the project, residents were not involved at all: 'We took the decision internally not to organise a separate participation project for the climate adaptation plan, but we have included principles to structure residents' participation' (GRaBS manager, Amsterdam)

Furthermore, no coalition building process was organized involving other residents or other stakeholders, such as housing associations. According to the public officials from Amsterdam, the housing associations would not have been interested in becoming involved because of their fear of potential cost increases: 'Currently, a housing association is not really responsible for any investments with respect to climate adaptation. And this is the point: They get a little bit sick of all these extra quality requirements, because they translate them into an additional cost. In Amsterdam, we have a system of a basic quality and in the case of anything above this, they say: Okay, we'll do it, but any more, and you will have to pay for it' (public official, Amsterdam)

Although the public officials' initial aim was the involvement of residents and other stakeholders, the focus changed during the course of the project to knowledge exchange within the closed GRaBS transnational city network. As a result, no local networks were developed to achieve policy change (Mintrom & Norman, 2009; Kern & Bulkeley, 2009). This implies that the potential adaptive capacity, through the heterogeneity of the stakeholders involved and opportunities to search for goal intertwinement, was not used effectively.

3.6 POLITICAL ATTENTION

One of the agreements between the partners in the GRaBS project was that the local authorities approve the climate adaptation plan. However, public officials from Amsterdam thought that the GRaBS project did not lead to greater political support for climate adaptation, even though the Climate Adaptation Action Plan was formally approved by the Borough Executive Board.

Ultimately, the policy makers in the transnational network did not pay much attention to increasing political support. Because formal political decisions about climate adaptation have not led to serious political action (Adger et al., 2005), the overall performance of the project was rather limited. Reasons for the lack of political interest included higher policy priorities for local politicians, such as tackling social deprivation, and the current lack of urgent climate problems. According to one official from Amsterdam, politicians are afraid that any investment in climate adaptation would give the wrong signal to other priorities in the borough (which they perceive to be urgent). Furthermore, local politicians often do not link low-income residents with vulnerability to climate change (Adger et al., 2007). Politicians' fear of additional financial claims also contributes to the lack of policy innovation in climate adaptation. One policy official from Amsterdam thought that climate adaptation should not even be that dependent on political support:

'I don't think you should rely on politics for this. It needs to get internalised in the regular organisation. This is why our approach is not to position it as a separate item on the agenda and to take action accordingly, but to integrate it in existing projects (…) Perhaps it's more effective not to talk about it all the time, but to simply get on with it' (policy official, Amsterdam).

In the past, the lack of financial resources has triggered public officials and politicians to opt for EU funding. However, this project has illustrated that EU funding is no guarantee that politicians will put climate adaptation higher on their agendas.

To summarise, the findings in this case study reveal that this transnational policy network did not enhance the local adaptive capacity. Fail factors were the sectoral approach, the lack of discretion reflected in common procedures and deliverables, the intrinsic limitations of developing context-specific knowledge, depoliticised policymaking, and the lack of attention to building up broad local professional networks and local coalitions to share resources and achieve policy change.

4 THE PROJECT FUTURE CITIES

In the 'FUTURE CITIES' project (2008–2012), twelve European partners from local authorities, water boards, planning companies, and project developers collaborated on green structures, water systems and energy efficiency. The city of Nijmegen in the Netherlands was one of the partners that contributed a case study. The project had four main objectives:

- Development of common evaluation methods for climate-adapted towns and cities – leading to an assessment check for climate-proof cities;
- Establishment of action plans for current structures so that the participating regions can adapt their strategies in a concrete manner;
- Implementation of combined construction solutions in pilot projects;
- Raising awareness among decision-makers and other influential groups about pro-active ways of tackling adaptation to climate change impacts (www.future-cities.eu).

4.1 MOTIVATION BEHIND PARTICIPATION IN FUTURE CITIES

The Nijmegen local authority stated that its reason for participating in FUTURE CITIES was to obtain additional financial resources: 'We only participate in those European projects for the money, just as everyone else does' (senior public environmental official, Nijmegen).

In addition, public officials from Nijmegen saw the FUTURE CITIES project as a chance to implement the city's water management policy along with a greening plan for the inner-city (Groene Allure Binnenstad), which already had political commitment: 'FUTURE CITIES didn't generate the greening programme. There was already commitment for it, and that's how we were able to introduce it in FUTURE CITIES (…) What is clear in a European project, is that everyone needs to support it. The Executive Committee and Management need

to support it in some way, because it will also cost the city a lot of money. Half of the budget has to be co-financed, but actually you should do much more' (public official, Nijmegen).
Hence, rather than the improvement of climate adaptation policies, it was the access to additional financial resources for their own programmes that motivated Nijmegen officials to get involved in the new EU project.

4.2 ASSESSMENT TOOL

One of the requirements of the FUTURE CITIES project was that partners should create a climate adaptation model or tool ('klimaatadaptatiecompas') for developing appropriate measures. The tool would demonstrate the effects of climate change on the city, the risks associated with those effects, opportunities, vulnerability and green and blue climate adaptation measures. However, just as in Amsterdam, the partners discovered: 'the difficulty is often that these measures can be linked to a street or a small project, but less easily to a larger entity, such as the district or neighbourhood level, because here things are so hard to bring together' (public official, Nijmegen).
Ultimately, it would be unrealistic to try to develop a common climate model, because the local context demands very specific information (Adger et al., 2005; Nelson et al., 2007). Add to that the scepticism of the involved parties and the usefulness of the model became very limited:
'We participate in the model for FUTURE CITIES, but I don't have much faith in it. In the end, most of the information comes from us (…) Actually, you have to do this at your own level. A tool is useful to guide you a little bit, but nothing more' (public official, Nijmegen).
In other words, although Nijmegen cooperated in the development of an assessment tool, stakeholders questioned its effectiveness. Just as in the GRaBS project, this illustrates the serious limitations in developing context-specific knowledge for transnational policy networks (Dolowitz & Marsh, 2000).

4.3 IMPLEMENTATION OF COMBINED MEASURES

Nijmegen public officials pointed out that their inner-city greening programme was used as a pilot project in the FUTURE CITIES programme. This was combined with their programme to disconnect roofs and paved surfaces from the sewer system. Both programmes started several years earlier than the FUTURE CITIES project. Therefore, no new policies were developed. Instead, public officials linked climate adaptation with the existing greening and water management policies on a project-by-project basis (VROM, 2010). This implies that participating in the transnational city network did not lead to new policy development for climate adaptation at the local level.

4.4 RAISING THE AWARENESS OF DECISION-MAKERS AND STAKEHOLDERS

Climate adaptation is not yet an important issue on the political agenda, due to former climate policy priorities, such as climate mitigation:
'The political agenda sets its own priorities. Despite the fact that they formally participate in EU projects, there are no aspects that the Executive Committee is immediately positive about. They consider sustainability as being of paramount importance. It is even part of the Coalition Agreement (…) But, all the years the local alderman has been in office, he has focused specifically on a related subject, namely climate mitigation' (senior policy officer, Nijmegen).
This implies that local climate policies are difficult to move in a new direction (Lindblom, 1959; Sabatier & Jenkins-Smith, 1993). Furthermore, according to the public officials from Nijmegen, substantial local budget cutbacks (50% of the previous budget) for implementing the greening the inner-city programme will make it difficult to implement green measures. Under these conditions, local politicians often prevent officials from developing new policies. This has led to climate adaptation policy being used merely as window dressing, only referring to existing policies (the greening and the disconnection programme) without taking it any further on

the policy agenda. This illustrates the politicians' opportunistic use of EU funding to implement regular policies, rather than using it to develop new climate adaptation policies.

In addition, public officials from Nijmegen perceive compartmentalisation within the municipal organisation an important barrier for the implementation of climate-proof elements in urban planning (Mees & Driessen, 2011): 'Our project leaders (in the urban planning department) work alone during the initiation phase. And this is the phase when it's decided if a project is going to be profitable or not. Then, plan economists are put to work. They only calculate initial costs, namely land development costs. They do not look at maintenance, nor at any initial or potential opportunities. These are not in the picture (…) Then, we suddenly sit down together and all think about it, but in the meantime some things have already been decided, which we are not allowed to change anymore' (public officer, Nijmegen).

This indicates that climate adaptation is not really integrated in urban planning, despite the fact that many authors stress the importance of this to facilitate the adaptive capacity (Adger et al., 2007; Blanco et al., 2009; De Bruin et al., 2009). For instance, goal intertwinement, which fosters synergic effects and shared costs, needs some sort of integration into urban planning processes (Koppenjan & Klijn, 2004). In addition, according to the public officials, the housing associations' commitment to climate adaptation differs depending on their willingness to be innovative and to invest. Housing associations and real estate developers perceive a green environment in particular as a sales tool in which, more particularly, the local authority invests and developers profit. As a public official observed: 'It sells well, and those real estate developers run off with the profits' (public officer, Nijmegen).

Finally, the transnational policy network FUTURES CITIES has not substantially enhanced the local adaptive capacity. Factors that contributed to this disappointing result were the limitations of this EU project to develop context-specific knowledge and the local focus on implementing only existing policies within the transnational policy network framework. Furthermore, policy entrepreneurs in this EU project invested little effort in involving other professional networks and stakeholders (Mintrom & Norman, 2009; Koppenjan & Klijn, 2004). Such involvement would have enhanced the adaptive capacity by sharing resources and could have overcome policy fragmentation. Other detracting factors were the dominance of climate mitigation policies and the political ban on making new policies.

5 SYNOPSIS

Our main question studied to what extent the EU climate adaptation projects could contribute to increasing the adaptive capacity of the participating cities with transnational policy networks. To answer this question, we applied a reflexive approach (Huitema et al., 2011) to evaluate the performance of two EU projects, namely the GRaBS project in the Amsterdam Nieuw-West Borough and the FUTURE CITIES project in the city of Nijmegen. The findings and synopses of the two case studies lead to three conclusions.

First, our main conclusion is that EU climate adaptation projects do not necessarily lead to an increased adaptive capacity on the local level. Evidence of this can be found in the way politicians use these types of projects to finance their regular policymaking. This attitude severely damages the effectiveness of the projects' empirical goals. Our findings reveal the way EU projects are filtered down in regular policymaking in Dutch municipalities and how the actual goal of improving climate adaptation gets watered down. This opportunistic political behaviour is a key detracting factor leading to the rather disappointing results of these EU projects in enhancing the local adaptive capacity.

Second, the EU project requirements for delivering common policy instruments can function as a straitjacket (Rhodes, 2000). They hinder the development of context- and location-specific climate adaptation measures and processes (Adger et al., 2005; Nelson et al., 2007). The common instruments can even be counterproductive. Their usefulness at the local or neighbourhood level is highly doubtful (see also Dolowitz & Marsh, 2000).

Third, the internal focus on timely deliverables draws attention away from local network building. Therefore, it is doubtful if the internal sectoral focus of the closed transnational policy networks will be effective in the longer term, due to a lack of attention to building up long-term stable local coalitions between politicians, the private sector and civil society (Mintrom & Norman, 2009; Kern & Bulkeley, 2009; Keiner & Kim, 2007; Koppenjan & Klijn, 2004). It is clear that all these factors are interrelated and have a negative cumulative impact on the performance of these transnational policy networks at the adaptive capacity level in the cities involved.

Table 1 gives an overview of the findings in the two case studies.

Main characteristics	**GRaBS**	**FUTURE CITIES**
Time-span of the EU project	3 years (2008-2011)	4 years (2008-2012)
Network members	Local and provincial governments, universities, non-profit planning and development companies	Local governments, water boards, for profit companies in planning and real-estate
Scope	Green and blue infrastructure in existing and new mixed-use urban development	Green structures, water systems, energy efficiency in existing urban structures
Motivation to participate	Nieuw-West Borough, Amsterdam: Continuity of cooperation with former partners Strategy to link climate adaptation with protecting the green structure	Local authority of Nijmegen: Continuity of EU funding Strategy to implement own existing policy programmes
EU projects' aims	Results	Results
Raising awareness/increasing expertise of professionals and decision makers	+ Urban and green designers – Spatial project managers – Politicians: lack of sense of urgency; other policy priorities; lack of budget Result: Policy fragmentation Lack of political support	– Spatial project managers – Politicians: lack of sense of urgency; window dressing; other policy priorities; ban on making new policies; lack of budget Result: Policy fragmentation Lack of political support
Developing a climate adaptation tool	– Not useful as design tool at the city district level – No increased knowledge about local climate effects Result: Inadequate context-specific climate adaptation tool	– Not useful as climate adaptation tool at the district or neighbourhood level Result: Inadequate context-specific climate adaptation tool
Development of climate adaptation action plans	Requirement of EU project – No guarantee for actual climate adaptation action Result: Instrument for window dressing	-

Implementation of combined measures	-	Linking climate adaptation with existing greening and water management policies Result: No policy innovation
Stakeholder and community involvement	+ Most important own aim during the start of the project – In practice, no broad local network developed owing to the focus on common deliverables and knowledge exchange within the project Result: No heterogeneity of local adaptive capacity	– No sharing of investment or profit Result: No heterogeneity of local adaptive capacity
Overall performance on the local adaptive capacity	Limited	Limited

Three-point scale for the contribution of the EU project to the local adaptive capacity: – (minus) negative contribution; +/–: neutral (no negative or positive contribution); + (plus) positive contribution.

Tab.1 Comparison of climate adaptation projects

6 CONCLUSIONS

Where does this leave European environmental policy? This paper addresses a dilemma of European policymaking: issues such as climate adaptation, as well as flood risk management (Hartmann, 2011), territorial cohesion (Hartmann & Hengstermann, 2014) and European corridors (Witte, 2014) require a common European approach, but the measures need to be implemented on the local level. There is a need for European frameworks for these issues, however, their location-specific contexts require a greater scope for discretion in their implementation on the local level (Reinhardt, 2008). Unfortunately, this scope for discretion and freedom at the local level allows opportunistic behaviour for stakeholders.

The above analysis reveals the constraints and limitations of implementation at the local level for EU funded projects. An important lesson learned is that in order to strengthen the adaptive capacity in today's European cities, a context-specific, integrative approach in urban planning is needed at all spatial levels. In this way, policy entrepreneurs can make a linkage between the issues in the transnational city network and the concerns in local politics and local networks. Therefore, realising a genuine, joint working capacity within and between institutions and the community involved in integrative urban planning strategies on all spatial levels is an urgent challenge that must be addressed in order to foster effective climate adaptation policies and to share costs (Hartmann & Spit 2014). This also implies that in urban governance research and practice (EU, national, local), much more attention should be paid to important process conditions and contextual factors for long-term capacity building in order to enhance adaptive capacity in cities. The opportunistic behaviour or local policymakers hinders the effective and efficient implementation of European policies. However, this claims not necessarily for more strict central policymaking (Wegener, 2012) or more rigorous reporting. Effectiveness and efficiency are not the only criteria for policymaking in Europe – the democratic legitimacy or fairness are other criteria (Hartmann & Spit 2015). This also means that in the future, transnational policy network projects are an option for pursuing climate adaptation, but the steps in policy change that they achieve might be very confined, due to the above stated reasons. This paper does not suggest changes in the approach of the European Union to implement policies via projects like GRaBS or FUTURE CITIES. It rather provides insights in its implementation and sets an agenda for further research: namely further research is needed on the matching and mismatching between intrinsic motivations of local policymakers and transnational policy objectives. In particular with a long-term issue such as climate adaptation, it is essential that future European projects respond to those motivations (in place of suppressing them). We must also accept that policy change for climate adaptation in cities still implies incremental change, due to the very specific local circumstances and conditions.

ACKNOWLEDGEMENT

This paper is based on the empirical work of Dr. Anita Kokx (in 2012) who died suddenly on December 29th 2012. The authors owe her much gratitude for the meticulous documentation of the empirical work.

REFERENCES

Adger, W.N., Arnell, N. & Tompkins, E. (2005). Successful adaptation to climate change across scales. *Global Environmental Change,* 15(2). 77-86.

Adger, W.N. (2010). Climate change, human well-being and insecurity. *New Political Economy*, 15(2). 275–292.

Adger, W.N., Agrawala, S., Mirza, MNQ, Conde, C., O'Brien, C.K., Pulhin, J., et al. (2007). Assessment of adaptation practices, options, constraints and capacity. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., Van der Linden, P.J. & Hanson, C.E. (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Cambridge: University Press. 717-743.

Adger, W.N., Dessai, S., Goulden, M., Hume, M., Lorenzoni, I., Nelson, D., et al. (2009). Are there social limits to adaptation to climate change? *Climate Change,* 93(3). 335-354.

Biesbroek, G.R., Swart, R.J., Carter, T.R., Cowan, C., Henrichs, T., Mela, H., et al. (2010). Europe adapts to climate change: comparing national adaptation strategies. *Global Environmental Change,* 20(3). 440–450.

Biesbroek, R., Klostermann, J., Termeer, C. & Kabat, P. (2011). Barriers to climate change adaptation in the Netherlands. *Climate Law,* 2(2). 181-199.

Birkland, T. (1998). Focusing events, mobilization, and agenda setting. *Journal of Public Policy,* 18(1). 53-74.

Blanco, H., Alberti, M., Forsyth, A., Krizek, K., Rodrígues, D., Talen, E., et al. (2009). Hot, congested, crowded and diverse: Emerging research agendas in planning. *Progress in Planning,* 71(4).153-205.

Carter, J. (2011). Climate change adaptation in European cities. *Environmental Sustainability,* 3(3). 193–198.

CEC (2009). *Adapting to Climate Change: Towards a European framework for Action*. Brussels: Commission of the European Communities.

CEC (2007). *Adapting to Climate Change in Europe – options for EU Action*. Brussels: Commission of the European Communities.

Colucci, A. (2012). Towards resilient cities: Comparing approaches/strategies. *Tema. Journal Of Land Use, Mobility And Environment*, 2012(2). 101–116.

De Boer, J. (2010). *On the Relationship between Risk Perception and Climate Proofing.* Amsterdam: Vrije Universiteit.

De Bruin, K., Dellink, R., Ruijs, A., Bolwidt, L., Van Buuren, A., Graveland, J., et al. (2009). Adapting to climate change in the Netherlands: an inventory of climate adaptation options and ranking of alternatives. *Climate Change,* 95(1/2). 23-45.

De Lange, M., Mastop, H. & Spit, T. (1997). Performance of national policies. *Environment and Planning B,* 24(6). 845-858.

Deltacommissie (2008). *Samen Werken met Water*. The Hague: Deltacommissie.

Dolowitz, D., & Marsh, D. (2000). Learning from abroad: The role of policy transfer in contemporary policy-making. *Governance,* 13(1). 5-24.

Dumollard, G., & Leseur, A. (2011). *Drawing up a National Adaptation Policy: Feedback on Five European Case Studies*. Paris: CDC Climate Research.

Füssel, H.M. (2007). Adaptation planning for climate change. *Sustainability Science,* 2. 265-275.

Galderisi, A., & Ferrara, F.F. (2012). Enhancing urban resilience in face of climate change. *Tema. Journal Of Land Use, Mobility And Environment*, 2012(2). 69–87.

Galderisi, A. (2014). Climate change adapation: Challenges and opportunities for smart urban growth. *Tema. Journal Of Land Use, Mobility And Environment*, 2014(1). 43–67.

Hartmann, T. (2011). *Clumsy floodplains: Responsive land policy for extreme floods*. Farnham, Surrey: Ashgate.

Hartmann, T. (2012). Wicked problems and clumsy solutions: Planning as expectation management. *Planning Theory,* 11(3). 242–256.

Hartmann, T., & Hengstermann, A. (2014). Territorial cohesion through spatial policies. *Central European Journal of Public Policy*, 8(1). 30–49.

Hartmann, T., & Needham, B. (eds) (2012). *Planning by law and property rights reconsidered*. Farnham: Ashgate.

Hartmann, T. & Spit, T.J.M. (2012). Managing riverside property: Spatial water management in Germany from a Dutch perspective. In T. Hartmann & B. Needham (Eds.), Planning by law and property rights reconsidered. Farnham, Surrey: Ashgate. 97-116.

Hartmann, T., & Spit, T. (2014). Capacity Building for Integrating Climate Adaptation into Urban Planning Processes: the Dutch Experience. *American Journal of Climate Change*, 3(3). 245-252.

Hartmann, T., & Spit, T. (2015). Dilemmas of involvement in land management – Comparing an active (Dutch) and a passive (German) approach. *Land Use Policy*, 42. 729–737.

Heinelt, H., & Niederhafner, S. (2008). Cities and organised interest intermediation in the EU multi-level system. *European Urban and Regional Studies,* 15(2). 173–87.

Holstein, A.N., & Schwaberger, C. (2011). How the INTERREG IVC project "GRaBS" can change European Cities. *REALCORP 2011 Proceedings.* Essen: Germany.

Huitema, D, & Meijerink, S (2010). Realizing water transitions. *Ecology and Society,* 15(2). 26.

Huitema, D., Jordan, D., Massey, E. Rayner, T., Van Asselt, H., Haug, C., et al. (2011). The evaluation of climate policy. *Policy Sciences,* 44(2). 179-198.

Hunt, A., & Watkiss, P. (2007). *Literature Review on Climate Change Impacts on Urban City Centres*. Paris: OECD.

IPCC (2014) Climate Change 2014: *Impacts, Adaptation, and Vulnerability: IPCC WGII AR5 Chapter 23*. Retrieved: www.ipcc.ch

Kamal-Chaoui, L., & Robert, A. (2009). *Competitive Cities and Climate Change*. Paris: OECD.

Keiner, M., & Kim, A. (2007). Transnational city networks for sustainability. *European Planning Studies,* 5(10). 1369-1395.

Kern, K., & Bulkeley, H. (2009). Cities, Europeanization and multi-level governance: governing climate change through transnational municipal networks. *Journal of Common Market Studies,* 47(2). 309–332.

Klijn, E.H., & Koppenjan, J. (2000). Public management and policy networks, foundations of a network approach to governance. *Public Management* 2(2). 135-158.

Kokx, A., & Van Kempen, R. (2010). Dutch urban governance? *European Urban and Regional Studies,* 17(4). 355-369.

Koppenjan, J., & Klijn, E.H. (2004). *Managing Uncertainties in Networks*. London: Routledge.

Lindblom, C.E. (1959). The science of "muddling through". *Public Administration Review,* 19(2): 79–88.

Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers to engaging with climate change among the UK public and their policy implications. *Global Environmental Change,* 17(3/4). 445-459.

March, J., & Olsen, J.P. (1976). *Ambiguity and Choice in Organisations*. Bergen: Universitetsforlaget.

Mastop, H. (1997). Performance in Dutch spatial planning: an introduction. *Environment and Planning B,* 24(6). 807-813.

Mees, H. and Driessen, P. (2011). Adaptation to climate change in urban areas. *Climate Law 2011,* (2). 251-280.

Mintrom, M., & Norman, P. (2009). Policy entrepreneurship and policy change. *Policy Studies Journal,* 37(4): 649-667.

Nelson, D., Adger, W., & Brown, K. (2007). Adaptation to environmental change: contributions of a resilience framework. *Annual Review of Environment and Resources,* (32). 395-419.

Papa, R. (2012). Editorial preface: Resilient cities. *Tema. Journal Of Land Use, Mobility And Environment*, 2012(2). 5–6.

PBL (Netherlands Environmental Assessment Agency) (2011). *Een delta in beweging*. The Hague: PBL.

Pinto, F. (2014). Urban planning and climate change: Adaptation and mitigation strategies. *Tema. Journal Of Land Use, Mobility And Environment*, 2014(Special Issue). 830–840.

Reinhardt, M. (2008) Identität und Zukunft des Wasserrechts als Bestandteil eines Umweltgesetzbuchs. *ZUR*, (7-8). 352–357.

Rhodes, R. (2000). Governance and public administration. In: Pierre J (ed) *Debating Governance.* Oxford: University Press. 54-90.

Runhaar, H., Driessen, P., & Snoer, L. (2009). Sustainable urban development and the challenge of policy integration. *Environment and Planning B* 36(3): 417-431.

Sabatier, P., & Jenkins-Smith, H. (1993). *Policy Change and Learning.* Boulder: Westview.

Stigt, R. van, Driessen, P., & Spit, T. (2015) A user perspective on the gap between science and decision-making. Local administrators' views on expert knowledge in urban planning. *Environmental Science and Policy, 47*. 167-176.

Teisman, G., Van Buuren, A., & Gerrits, L. (2009). *Managing Complex Governance Systems, Dynamics, Self-organisation and Coevolutions in Public Investments*. London: Routledge.

Uittenbroek, C.J. (2014). *How mainstream is mainstreaming? The integration of climate adaptation into urban policy*. Utrecht: Utrecht University.

Van Buuren, A., Edelenbos, J., Eshuis, J, Klijn, E.H., Nooteboom. S., & Teisman, G. (2007). Feasibility of adaptation options. In: Van Ierland, E.C., De Bruin, K., Dellink, R.B. & Ruijs, A. (eds) *Routeplanner naar een Klimaatbestendig Nederland, Adaptatiestrategieën*. Wageningen: WUR. 68-73.

Vonk, G., Geertman, S., & Schot, P. (2005) Bottlenecks blocking widespread usage of planning support systems. *Environment and Planning A,* (37). 909-924.

VROM (Ministry of Housing, Spatial Planning and the Environment) (2007). *Maak Ruimte voor Klimaat! Nationale Adaptatie Strategie.* The Hague: VROM, et al..

VROM (Ministry of Housing, Spatial Planning and the Environment) (2010). Doorwerking van Klimaatadaptatie in Ruimtelijke Plannen. VROM-Inspectie. The Hague: VROM.

Wegener, M. (2012). Government or governance? The challenge of planning for sustainability in the Ruhr. In: Hartmann, T., & Needham, B. (eds.) *Planning by law and property rights reconsidered*. Farnham: Ashgate. 157–168.

Witte, P. (2014). *The Corridor Chronicles. Integrated perspectives on European transport corridor development*. Delft: Eburon.

Witte, P., & Spit, T. (2014). Sectoral drawbacks in transport: Towards a new analytical framework on European transport corridors. In: Isabella, M.L. (ed) *Analytical Decision-Making Methods for Evaluating Sustainable Transport in European Corridors*. Berlin: Springer. 47-62.

IMAGE SOURCES

Cover image: Martin H. Hartmann, www.pressemartin.com

AUTHORS' PROFILES

Thomas Hartmann

Dr. Thomas Hartmann is assistant professor at the Dept. Human Geography and Spatial Planning at Utrecht University. He researches on the relationship between land and water, with a focus on river floods and retention. Thereby, he looks from three perspectives to the topic: planning theory, law & property rights, and water governance.

Tejo Spit

Prof. Dr. Tejo Spit is full professor in Urban and Regional Planning. He is specialized in land policy, planning methodology, infrastructure planning, and administrative aspects of spatial planning. He has been working both in the academic world (University of Nijmegen and Utrecht University) and in the more problem-oriented world of municipalities. In that way, he has developed wide knowledge of spatial planning in (local) practice.

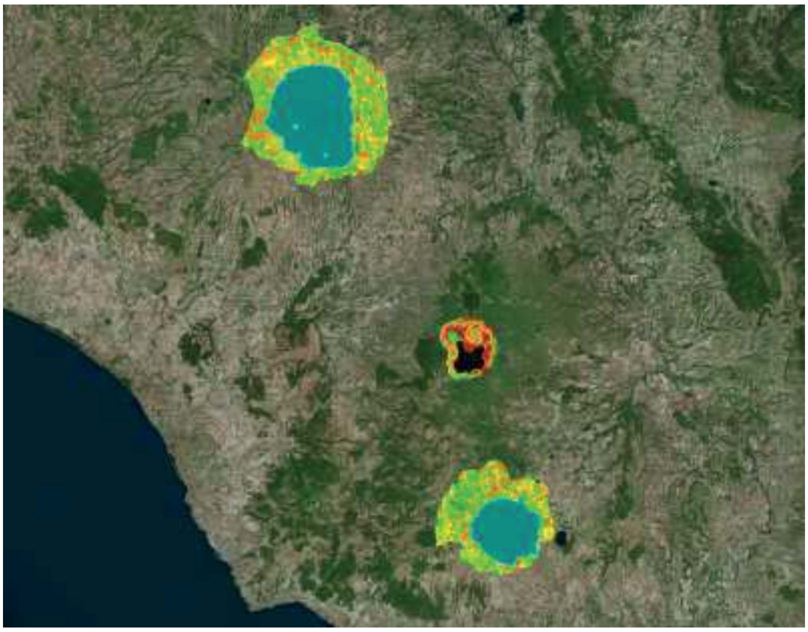
TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2015) 69-81
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2885

review paper received 20 January 2015, accepted 24 April 2015

www.tema.unina.it

How to cite item in APA format:
Di Giacomo, T. V. (2015). Interactivity of webgis for the simulation of land development. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 69-81. doi: http://dx.doi.org/10.6092/1970-9870/2885



INTERACTIVITY OF WEBGIS FOR THE SIMULATION OF LAND DEVELOPMENT

TULLIA V. DI GIACOMO

Tuscia University
e-mail: tulliadigiacomo@tiscali.it

ABSTRACT

In the definition of scenarios as key components underlying the decisions on city's and territory's transformation processes stands the comprehension of the interactions between multiple aspects that influence that dynamics.
The spatial data knowledge and the development of new ICT solutions which can guide the planner towards strategic, reliable and shared decisions are essential.
It is proposed a methodology in which to specialize the special approach established in previous projects developed by extending and implementing GIS technology Geographic Information System towards online interoperability.
The control of the effects of changes in land use in environmental quality, particularly in the water resources management, can thus become operational in the network through the application of innovative tools able to meet the new challenges of urban regeneration.

KEYWORDS:
GIS, WEBGIS, simulations, land use planning

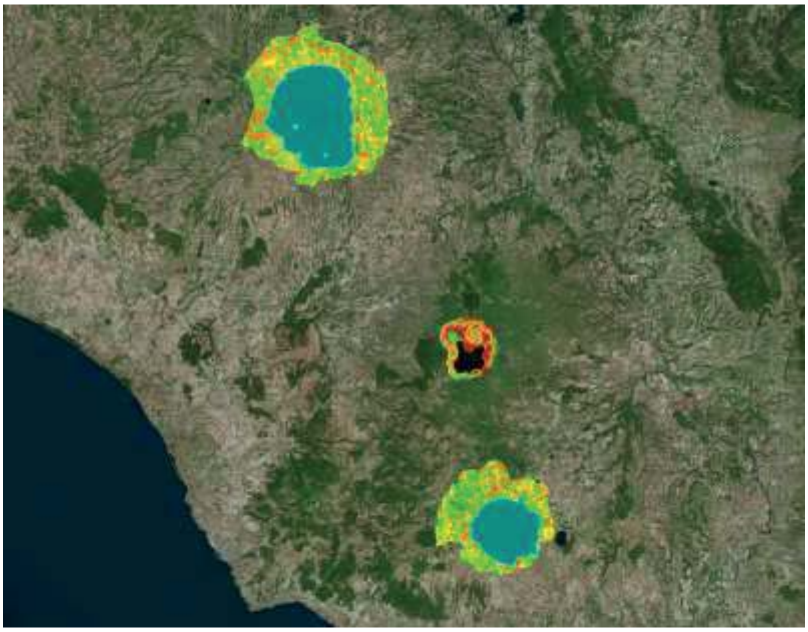
TeMA
有关土地使用、交通和环境的杂志

TeMA 1 (2015) 69-81
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2885

review paper received 20 January 2015, accepted 24 April 2015

www.tema.unina.it

How to cite item in APA format:
Di Giacomo, T. V. (2015). Interactivity of webgis for the simulation of land development. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 69-81. doi: http://dx.doi.org/10.6092/1970-9870/2885



土地开发模拟中WEBGIS的交互性

TULLIA V. DI GIACOMO

Tuscia University
e-mail: tulliadigiacomo@tiscali.it

摘要

在对城市与土地转化过程进行决策时,有一些情境是支撑决策的关键组成部分. 在对这些情境解释时,需要理解对这一动态形成影响的多个方面之间的互动.空间数据知识与新信息通信技术解决方案的制定至关重要,它们可以指导规划者做出具有战略性,可靠性与共享性的决策.
这提出了一个方法, 能够将在以往项目中业已形成的特别方法专门化, 这些项目的开发是通过延伸并落实 GIS 技术地理信息系统的在线互操作性而实现的. 通过应用能够应对城市重建新挑战的创新工具, 控制用地变化对环境质量造成的影响尤其是水资源管理 在网络中将具有可操作性.

关键词
地理信息系统, 网络地理信息系统,
模拟, 土地使用规划

1 INTRODUCTION

Between 2009 and 2050, the world population is expected to increase by 2.3 billion, from 6.8 to 9.1 billion.
At the same time, urban populations are projected to increase. Thus, the urban areas of the world are expected to absorb all of the population growth over the next four decades; today around half of the people living on earth are living in urban areas and by 2050 that proportion will be 70%. Furthermore, most of the population growth expected in urban areas will be concentrated in the cities and towns and their surroundings.
The new contemporary landscapes, need special attention to the design of open spaces, of voids, of marginal or disposed areas, of interstitial spaces, of the so called SLOAP, the "Space Left Over After Planning", for urban peri-urban and regional regeneration.
Following an inter-scalar approach will allow coordinated and consistent actions from the local scale of the architectural dimension to the wide-scale of land planning.
In this perspective, it is clear the relevance of care and management processes of natural and man-made territory to counter those phenomena of degradation, abandonment or even damage of land resources and landscape.
In urban areas, for example, the phenomenon of the flow of surface water (run-off) is now considered a major source of degradation of rivers and lakes.
In the urban environment the waterproofed surface of paved areas and buildings, promoting the reduction of the time of concentration fosters the rapid run-off to the receiving bodies.
The receiving bodies gather then, from storm water, untreated waste water and water full of nutrients, sediment and solid material variously polluting.
The purification of rainwater filtered slowly through the soil, as happens in natural environments such as forests, grasslands and wetlands is prevented in urban areas from sealing terrain.
The influx of large volumes of water that occurs at prolonged or intense rainfall events, determines morphological and hydrological significant consequences on the receiving bodies related to the sudden increase of flow and velocity of runoff and erosion.
The sudden increase of the flow and the speed flow rates causes harm to fish and other aquatic life, or can make useless the body of water for which is designated (drinking water, bathing water, irrigation water).
The need for effective control and management of the flow of water of the urban areas and especially of the large metropolitan areas is evident.
Issues related to greater environmental sustainability of built areas and the conservation of soil as non-renewable resource push towards finding solutions to strategic planning for future scenarios of management and regeneration.
The European Innovation Partnership on Water - EIP Water in short - is an initiative within the EU 2020 Innovation Union. The EIP Water facilitates the development of innovative solutions to address major European and global water challenges and has identified five thematic priorities: water reuse and recycling; water and waste water treatment, including recovery of resources; water and energy integration; flood and drought risk management; and the role of ecosystem services in the provision of water related services in both urban and rural areas.
The answer to these immanent needs is the construction of appropriate ICT tools to address the greatly accelerated urban dynamics and to drive the reduction of pollution linked to the urban water cycle.
For this purpose, it is essential to know the characteristics of the present context and therefore the availability of geographic information. A Geographic Information System (GIS) can be defined as the set of technologies that can perform any operation on geographic information, from acquisition and compilation through visualization, to querying, modeling analysis, sharing and archiving. (Longley et al., 1999, 2010). As claimed by the geographer Michael F. Goodchild, the GIScience has as its challenge to find useful and

effective ways to capture and represent the infinite complexity of the geographical domain in the limited space and in the binary alphabet of a computer. Alongside this there is the challenge of characterizing what is inevitably left out, and the evaluation of its impact on the results of GIS operations.
With the Legislative Decree no. 152/99 and subsequent amendments, the legislature for the first time deals with the problem of impacts related to storm water (Article 39, paragraph 1).
The decree refers to Regions the regulation of cases where the runoff water, first rain and washing of the external areas are conveyed, collected and purified, in relation to their activities, if there is risk of pollution by hazardous substances or otherwise substances that may adversely affect the achievement of the objectives of quality of water bodies (Article 39, paragraph 3).
The issues object of this research are widely shared at European level and are in line with the principles of the Joint Programming Initiative of the European Community in the field of new challenges "Water challenges for a changing word".

2 STUDY AREA

As paradigmatic case studies were chosen the neighborhoods of Acilia and Infernetto in an area in the south of the city of Rome, whose surface waters are drained from the channel Palocco. Acilia Infernetto and are two of the peri-urban neighborhoods of Rome that have clear problems related to urban expansion, which began in the 50s, and related to the soils sealing. The Palocco Channel, located between the districts of Acilia and Infernetto, falls into that category of canals / ditches whose bed, a time of natural origin, was deputy to the drainage of surface water from a purely natural environment or, at most, semi - natural in the case of the presence of areas intended for farming and grazing.
Today this channel is being profoundly altered with a waterproofed riverbed that is required to perform its hydrological function in a highly urbanized environment.
Currently the Palocco Channel, which extends for a length of about 10.500 kilometers, drains the water coming from the districts of Acilia and Casal Palocco - Infernetto (approximately 100,000 residents) before crossing the Presidential Estate Castelporziano protected area and thus reaching the Tirrenian sea.
The main problems ascribable to this waterway are linked to hydrological instability, the transport of pollutants from diffuse sources of pollution and the high social and economic costs that its management put in place.
The mitigation of these problems, in addition to the increasing risk due to intense rainfall events becoming more frequent, it is now necessary to comply with Directive 2000/60/EC. The full and correct implementation of the Directive 2000/60 / EC, WFD (Water Framework Directive), which incorporates the Directive 91/271 / EEC on Urban Wastewater and the Directive 91/676 / EEC on nitrates from agricultural sources constitutes a indispensable condition for the attainment of the "good ecological status" required by 2015.
The management of surface water, is currently the only tool that can limit the system crisis.
For the natural and semi - natural protected area of Castelporziano and Infernetto, the experience gained so far leads to believe GLEAMS (Groundwater Leaching Effects of Agricultural Management Systems; Knisel, 1993) at the field scale and SWAT (Soil and Water Assessment Tool) to the basin scale, the most appropriate management models, which have had even more of an experimental evidence already experienced in the Lazio Region. GLEAMS and SWAT models (in their respective scales) simulate the mobilization of nutrients and pesticides, caused by the rains, in runoff, soil erosion and leaching.
These models are suitable for planning issues precisely because they focus on land use. Depending on land use are then simulated these environmental processes and, for this reason, although physical models, are classified in the category of managerial models.
The simulations allow the impacts' analysis of land management activities and the evaluation of environmental management decisions' performance.

3 OBJECTIVES, MATERIALS AND METHOD

The primary objective is to provide a practical contribution to the construction of the future landscape focusing on quality, well-being and environmental sustainability of the contemporary city and above all of marginal areas to contribute to the optimization of planning and urban regeneration.
Two realized projects are examined in the following to allow the detection of the computer tools able to achieve the set targets towards the definition of a proper environmental sustainability in urban and territorial transformations and in the identification of possible options for action.
The basis of the technological structure is founded on a cognitive analysis of the various aspects that are combined to make the environmental panorama complex such as the characteristics of river beds, banks and the consequent risks both in the soil conservation, in the defense of the landscape values and in the protection of natural resources.
These considerations underlie the analysis and evaluation of territorial systems and rural landscapes, examined in their environmental context and within the framework of natural and anthropogenic faced risks and socioeconomic variables from which are affected.
The acquired result concerns the design of GIS (Geographic Information Systems) for the synthesis between the urban planning needs and nature conservation and for the assessment of vulnerability and environmental risk of the examined areas.
The thematic decomposition into homogeneous layers simplifies the interpretation of both the environmental situation and the stratigraphy of skills and different existing rules leaving those who view the task of interpreting the relationships that exist in reality.
The first example concerns the Urban Planning GIS of a City of more than 65.000 residents in the Lazio Region, the second example concerns the Project created in the collaboration between one SME and some Research Institutions in the further developed of the technology utilized in the first case study.

3.1 URBAN PLANNING GIS

The GIS - Geographic Information System of the City of Viterbo was designed to provide map information, information on planning instruments and for the research of technical practices.
The GIS, allows to manage a large amount of data and is set up as the main reference for all the information and acts of planning. Therefore, the GIS makes available to all citizens, constantly updated data and allows to see the basic cartography to navigate on the interactive maps.
The integrated applications in the GIS allow access to legislation and to the factsheets for each object of interest (metadata) enabling, where necessary, to download forms and official documents.
The GIS - Geographic Information System makes environmental and territorial information available to a wide audience by exploiting the municipal information assets and appears as a chance to boost entrepreneurship and create jobs and new markets.
Transparency on the work of the institutions and the use of public resources becomes therefore possible and the heritage of the information is accessible and located in the territory.
The plurality of geographic data structured in the GIS (Fig. 1) come also from external geodatabase as the one of the National Cartographic Portal, or of the Lazio Region and of the Province of Viterbo as well as from the municipal offices and from Google Maps and Bing (Microsoft). The input data of the Urban Planning GIS cover many themes, from the Master Plan (Piano Regolatore Generale PRG) to higher-level constraints (hydrogeological plan PAI, hydrogeological constraint), cadastral information, road network, sewage system, green network..., all information that contribute to assemble land management and planning essential knowledge heritage.

Fig. 1 Geodatabase scheme

For the construction of the GIS was necessary to proceed to the re-projection of the cartographic bases of the PRG on the ED50 Zone 33 N projection to overlay the planning instrument both on technical maps and on aerial photos.

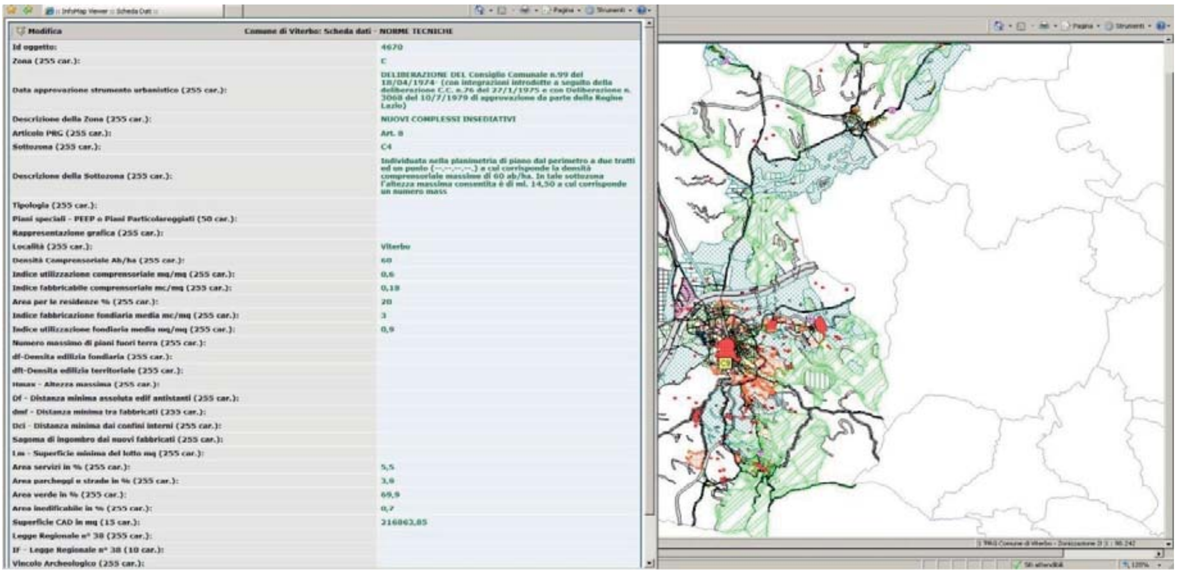


Fig. 2 Example of Web GIS with the information content

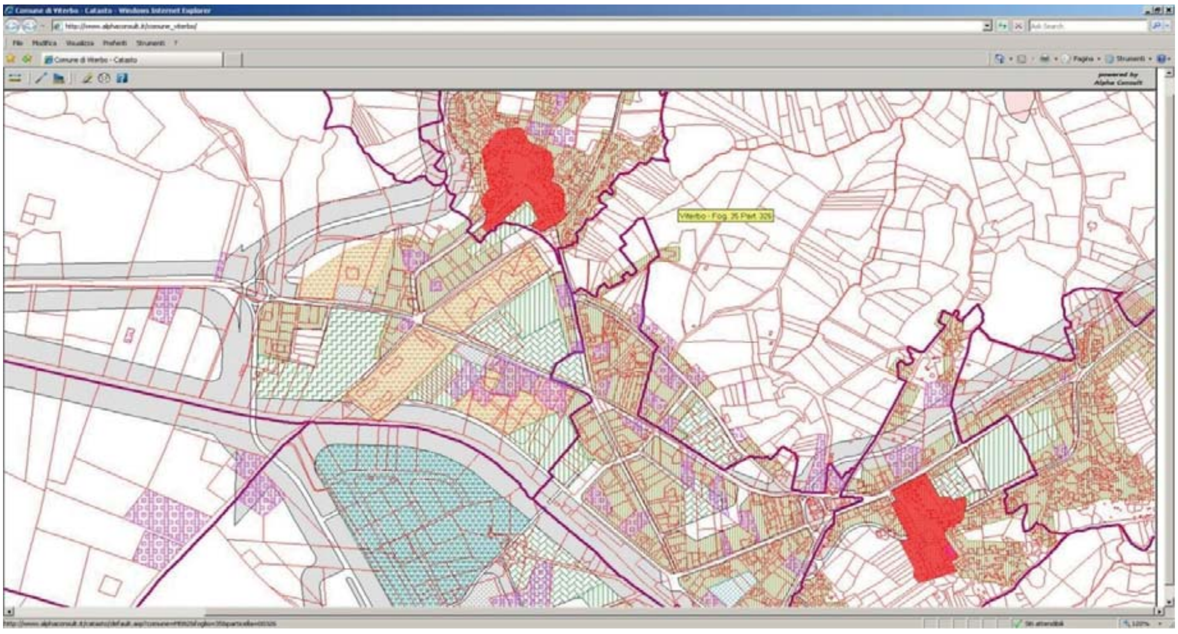


Fig. 3 Example of Web GIS with the PRG and Cadastre overlay

3.2 PROJECT FILAS CO-RESEARCH PST-CSA

The project PST-CSA Strategic Territorial Planning for a Correct Environmental Sustainability comes from the collaboration of a group composed of five research institutes coordinated by the SME Alpha Consult Ltd.
The Project Partners are therefore those listed in the following table (Tab.1).

The project aimed at testing methods of analysis to determine a sustainable planning criteria for environmental systems sensitive to anthropogenic activities which are the volcanic lakes of the Lazio Region and the Pontine plain.
The project portal collects the work of Alpha Consult to realize the on-line Geographic Information System for the dissemination of the data produced by the Research Institutes for the project PST-CSA Strategic Territorial Planning for a Correct Environmental Sustainability.

The project aimed at putting online a web service made up of geographic database queries' tools that relies on the Geographic Information System.

The web service created for the project is provided with a user interface that allows the use of online modeling for interactive study of the impacts that changing land use has on the ecosystem of lakes and reservoirs with mechanical drainage.
Through this online service, the impact of diffuse sources of pollution (mainly nitrogen and phosphorus) on surface water bodies of the Lazio Region, in particular on the volcanic lakes and the drainage canals managed with mechanic drainage, can be analyze and simulate.
The following map shows the study area, comprising the catchment areas of the five volcanic lakes of the Lazio Region and the Pontine plain: Bolsena, Vico, Bracciano, Albano and Nemi.

ALPHA CONSULT	Alpha Consult Ltd.
	University of Tuscia - Department of Agriculture, Forests, Nature and Energy (DAFNE)
CRA-CMA	National Research Unit for Climatology and Meteorology applied to agriculture (CRA-CMA)
CRA-RPS	National Research Centre for the Study of the Relationships between Plant and Soil (CRA-RPS)
	University of Rome Sapienza Department of Architecture and Design (DIAP)

Tab.1 The Project Partners

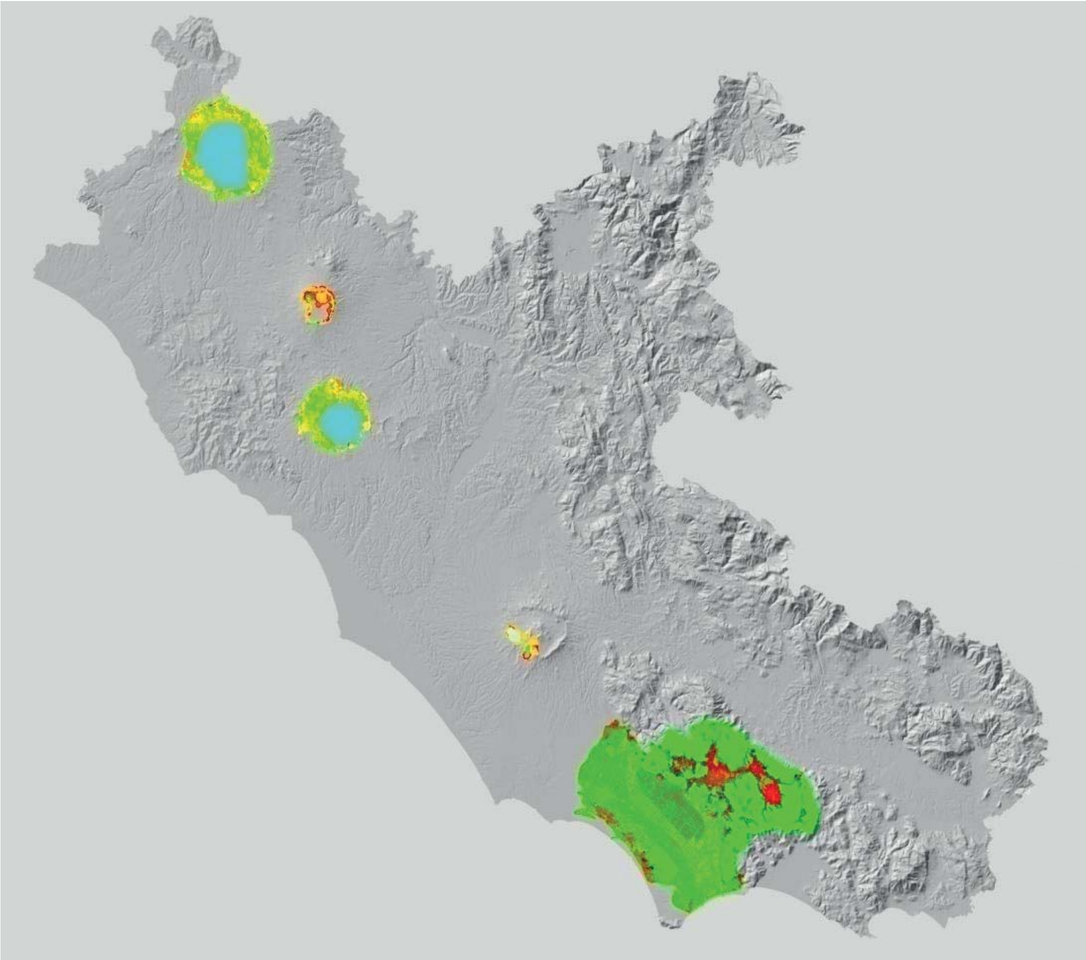


Fig. 4 The case studies: Bolsena, Vico, Bracciano, Albano, Nemi and the basins of the rivers Sisto, Rio Martino and Badino-Amaseno

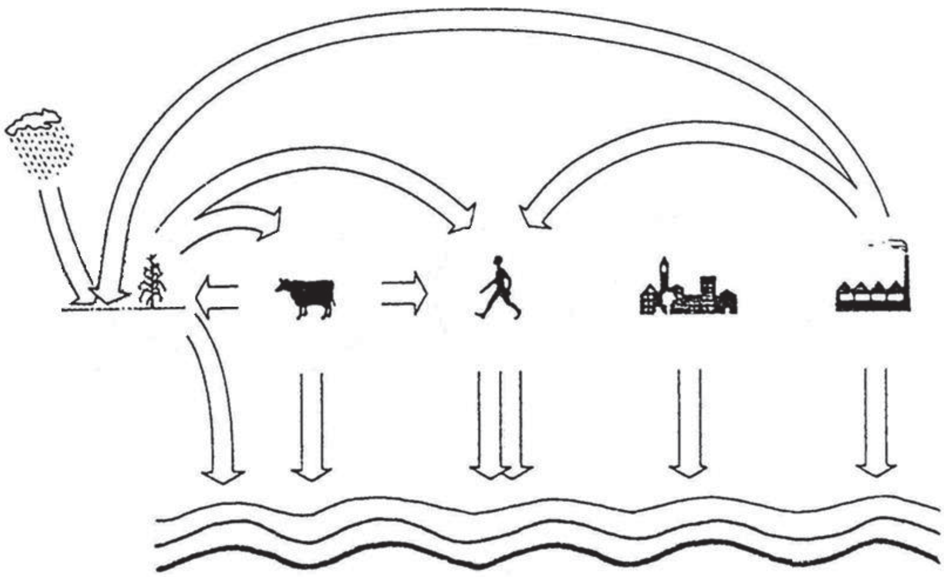


Fig. 5 The direct or indirect impacts on water bodies

The thematic geographical knowledge of the area, whose availability is one of the most challenging issue to be overcome in dealing with environmental topics, derived from years of study by the Alpha Consult and the Research Institutes, were organized in the GIS and poured in the Portal.

Specifically the main topics are those in the following table (Tab. 2.).

- Mapping of the CTR CTRN (scale 5.000 10.000 and 100.000); - Cartography IGM 1:25.000 and 100.000) - Cadastral Cartography - Administrative boundaries - Aerial photos of 1996, 2000, 2005 and 2010 and from Google maps and Bing - Agricultural soil map of the Lazio Region 250.000 - Land Use maps: _Corine Land Cover 1991: European land use database in scale 1:100,000; _CUS 2005: land use maps by Region Lazio 25.000 _Detailed land use derived from direct ground soli surveys of the project areas with additional photo interpretation by the University of Viterbo "UNITUSCIA" (in progress) - Watershed maps by the National Printing Office - Geological Map of the Lazio Region in the scale of 1:25.000	- Hydro geological Map of the Lazio Region in 1:25.000 - Intersection between river basins and TCEV Maps (regionalization of rainfall map) - PRG: Local Government Master Plans - Regional landscape Plan - PAI Hydro-geological hazard plan of the Lazio Region River Basin and of the Tiber River Basin Authorities - Ecosystem Services: Riding Trails, Gorges mapping and trails (taken from the planning documents of the Province of Viterbo: the project for the touristic development of the old roman roads such as: Via Cimina, Via Clodia and Via Amerina. - Archaeological map of the Province of Viterbo - Project LIFE Rewetland: The REWETLAND project intends to set up a wide-scale Environmental Restoration Programme in the "Agro Pontino", an area with critical conditions of water pollution, mainly caused by an intensive agricultural activity, with the techniques of constructed wetlands

Tab.2 The main topics

The dissemination of data is obtained extending GIS technology on the internet, providing a powerful tool to share related information available to multiple users simultaneously. In the realization of the project on this platform have been developed accessory functions in order to ensure that in addition to classic queries connected to the polygons on the GIS (to select, view and edit values) the user could also operate to repeat the simulations made by the GLEAMS model highlighting the results on the cartography.

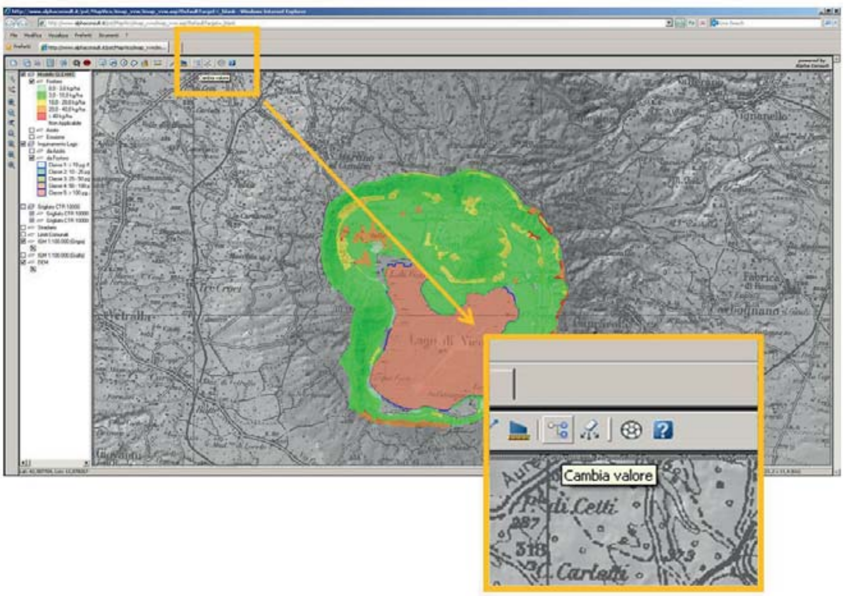


Fig. 6 Accessory functions to perform simulations

To make interactive simulations made with GLEAMS Model the selections made on the online mapping needed to be managed by a number of suitable features that produced the end result. The result is obtained as a given polygon, and as an aggregate of all the polygons in the river basin whereas taken together, provide the environmental quality of the lake.

The main difficulty has been to ensure that the user could perform a interactively simulation changing online the value of land use to view the results in the layer of the health of the lakes.

The legend of the land use map CUS 2005 was reduced to define the land use classes to be included in the model (Fig. 7). Land use classes used for modeling refer to:

- Ryegrass corn;
- Forest;
- wasteland;
- alfalfa or lucerne
- hazelnut
- Not applicable.
- Beside the simulation of the contribution of agriculture is assumed to consider the polygon "not applicable" in case the contribution to pollution of the polygon is led through a sewer system to a wastewater treatment plant (the drainage system around the lake).

COD	DESCRIZIONE		
11	Insediamento residenziale	urbano	NULLO
12	Insediamento produttivo, dei servizi generali pubblici e privati, delle reti e delle infrastrutture	urbano	NULLO
131	Aree estrattive	urbano	NULLO
141	Aree verdi urbane	urbano	NULLO
143	Cimiteri	urbano	NULLO
221	Vigneti	arboree (culture permanenti)	NOCCIOLETO
222	Frutteti e frutti minori	arboree (culture permanenti)	NOCCIOLETO
223	Oliveti	arboree (culture permanenti)	NOCCIOLETO
231	Superfici a copertura erbacea densa	seminativi	LOIESSA-MAIS
241	Colture temporanee associate a colture permanenti	arboree (culture permanenti)	NOCCIOLETO
242	Sistemi colturali e particellari complessi	seminativi	LOIESSA-MAIS
243	Aree prevalentemente occupate da coltura agraria con presenza di spazi naturali importanti	foraggere	MEDICA
311	Boschi di latifoglie	bosco	BOSCO
312	Boschi di conifere	bosco	BOSCO
313	Boschi misti di conifere e latifoglie	bosco	BOSCO
321	Aree a pascolo naturale e praterie d'alta quota	foraggere	MEDICA
322	Cespuglieti ed arbusteti	incolti	INCOLTO
323	Aree a vegetazione sclerofilla	incolti	INCOLTO
331	Spiagge, dune e sabbie	aree non agricole	NULLO
332	Rocce nude, falesie, affioramenti	aree non agricole	NULLO
333	Aree con vegetazione rada	foraggere	MEDICA
411	Paludi interne	aree non agricole	NULLO
421	Paludi salmastre	aree non agricole	NULLO
422	Saline	aree non agricole	NULLO
423	Zone intertidali marine	aree non agricole	NULLO
521	Lagune, laghi e stagni costieri	aree non agricole	NULLO
523	Aree al di là del limite delle maree più basse	aree non agricole	NULLO
1321	Discariche e depositi di cave, miniere, industrie e collettività pubbliche	urbano	NULLO
1322	Depositi di rottami a cielo aperto, cimiteri di autoveicoli	urbano	NULLO
1331	Cantieri e spazi in costruzione e scavi	urbano	NULLO
1332	Suoli rimaneggiati ed artefatti	incolti	INCOLTO
1421	Campeggi, strutture ricettive a bungalows o simili	urbano	NULLO
1422	Aree sportive	urbano	NULLO
1423	Parchi di divertimento	urbano	NULLO
1424	Aree archeologiche	urbano	NULLO
2111	Seminativi semplici in aree non irrigue	foraggere	MEDICA
2112	Vivai in aree non irrigue	seminativi	LOIESSA-MAIS
2113	Colture orticole in pieno campo, in serra e sotto plastica in aree non irrigue	seminativi	LOIESSA-MAIS
2121	Seminativi semplici in aree irrigue	seminativi	LOIESSA-MAIS
2122	Vivai in aree irrigue	seminativi	LOIESSA-MAIS
2123	Colture orticole in pieno campo, in serra e sotto plastica in aree irrigue	seminativi	LOIESSA-MAIS
22411	Pioppeti, saliceti, altre latifoglie	bosco	BOSCO
22412	Conifere a rapido accrescimento	bosco	BOSCO
2242	Castagneti da frutto	arboree (culture permanenti)	NOCCIOLETO
2243	Altre colture permanenti	arboree (culture permanenti)	NOCCIOLETO
3241	Aree a ricolonizzazione naturale	incolti	INCOLTO
3242	Aree a ricolonizzazione artificiale	foraggere	MEDICA
3341	Boschi percorsi da incendi	bosco	BOSCO
3342	Altre aree della classe 3 percorse da incendi	incolti	INCOLTO
3343	Aree degradate per altri eventi	incolti	INCOLTO
5111	Fiumi, torrenti e fossi	aree non agricole	NULLO
5112	Canali e idrovie	aree non agricole	NULLO
5121	Bacini senza manifeste utilizzazioni produttive	aree non agricole	NULLO
5122	Bacini con prevalente utilizzazione per scopi irrigui	aree non agricole	NULLO
5123	Bacini con prevalente altra destinazione produttiva	aree non agricole	NULLO
5124	Acquacolture	aree non agricole	NULLO

urbano	GLEAMS NON APPLICABILE
arboree (culture permanenti)	NOCCIOLETO
seminativi	MAIS
incolti	INCOLTO
aree non agricole	GLEAMS NON APPLICABILE
bosco	BOSCO
foraggere	MEDICA

Fig. 7 The reduced land use classes

The user may decide to change directly on the screen the type of land use of one or more polygons, by acting on the theme of the overlay. The system (geodatabase) identifies the selected polygons and change the value of contributions of environmental modeling parameters such as phosphorus or nitrogen.

These simulations are driven and based on predefined scenarios stored in the database that can be improved.The application allows you to view the data of the simulation based on the changed values, and then display the result of the state of health of the lake that these areas represented by polygons will provide the environment due to the changes made. That is not only to enable queries to the database but to be interactive in the use of GLEAMS model data, all without leaving the Web GIS cartographic consultation.

!
!
Thus, the portal gives access to structured data that have been placed on the Web Server and the interaction on the Web GIS determines the possibility of multiple users on a network to work on a common territorial board and simulate scenarios placed at the disposal of all. On the following image (Fig. 8) the results after changing values in the case of phosphorus.

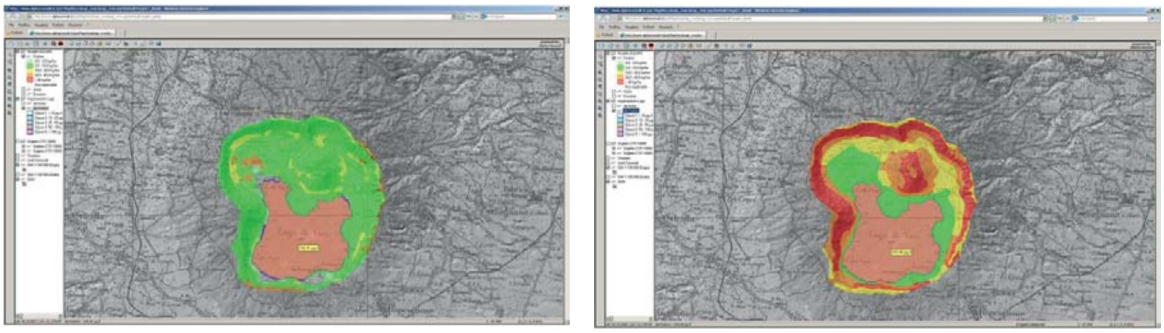


Fig. 8 Before and after the simulation

The work of the University of Tuscia produced GLEAMS model processing that have been conferred to the information system in excel format.
In order to accommodate the modeling data was necessary to perform the overlap between the basic themes (overlay) and then producing tables output in the geodatabase that describe the polygons overlay. The polygons of the overlay have been connected to modeling data processed in the SQL database .
The approach of the project PST-CSA is completely opened to the overlay of the topics considered essential for the application of the pollutants valuation models.
The value is properly given by taking into account the parameters of the polygon overlay whose waters arrive in the catchment area of the lake.
The special feature of the used method is therefore to have put on-line at the disposal of an evaluator who consults the system the layer resulting from the intersections of the types of all the issues that enter the GLEAMS model.
All themes have been traced back to a single informative level in which the polygons generated by the intersections of the various plans have the characteristic of having a single value in each thematic layer.
In this way, it is possible to graphically display the influence on the territory of a single theme but also the application of a weight due to modeling and see the results of the envelope of the information on another topic, in this case the lake's health.
This methodology allows to have discretized the modeling reality in individual thematic topological overlay where polygons represent the homogeneous characteristics of slope, land use etc.
This way you have a chance to go into detail and improve the system error more is deepening the knowledge of the specific theme.
In the case of the scale of the project was obtained an intersection of themes with a sufficient accuracy to be able to adequately represent the result of the transport of nutrients in the polygon that represents the receiving body, the lake.
The novelty of the process was to define the color changes and therefore the quality of the individual nutrient.
In this way it is possible to assess the issues of the contributions of modeling and which polygons contribute with nutrients in the lake.
This result was achieved and can be reformulated interactively online by the user by changing the values using the developed functions thanks to the simultaneous use of an on-line map server and a database server that offer a synergistic service for displaying modified modeling data.

The web GIS device then becomes a reality's interpretation tool through the use of established modeling and becomes a tool for the planner: no longer a GIS to produce risk's maps but a geodatabase on which to apply a spatial modeling to simulate alternative land use planning scenarios.

The large amount of data that a planner must keep under control now needs the help of the computer tool that extends the analytical capabilities of human mind. The planner has to set the rules of the system being able to assist in the development of modeling and being therefore capable of a critical reading of the results.

By merging the two professions of computer science and spatial planning comes the opportunity to give back to the land planner a tool to manage complex processes and to have the basis for a future environmental monitoring of what has been achieved refining results identified in modeling with field sensors.

4 CONCLUSIONS

The proposed methodology and the geographic information system (GIS) on line (WEBGIS) to be applied to the case study of the Palocco Channel will allow all governments of the region to take advantage of a methodology to perform simulations of scenarios related to territorial changes and the impact of those changes on the state of water resources.

This tool will help incisively in decision-making processes related to scheduling, planning and land management.

The main users of this tool are local governments to support the design, upgrading and management of urban and peri-urban areas; professionals and businesses for development opportunities; residents in urban and peri-urban areas as end users.

The strength of the project, in fact, is represented by the potential applications of transversal interest for local authorities, trade associations, professionals and for civil society.

The result is the provision of a flexible and upgradeable tool to support the preparation of planning instruments (for example urban planning implementation, structural plans, landscape plans, water conservancy plans, Provincial Coordinating plans, procedures for Environmental Impact Assessment, constraint plans, regional planning and landscape plans) and the study of the effects of projects to apply a careful management of water resources of rural and peri-urban areas.

The contribution in the realization of a number of tools to help the planner on handling a considerable amount of data will allow different future developments. Some of the most important future developments apply to the ability to use digital information for the territorial development, the possibility to exploit local information assets for job creation and to encourage the development of other private applications on the public data made. The new features developed specifically for the portal allow then to perform simulations on the network. These simulations are designed to aid the planner to create different planning scenarios and to show the changes that planning involves in the water quality of the lakes.

The display update is automatic and allows to extract different data scenarios, which are essential for the planner. According to Professor Bernardo Secchi: "The definition of scenarios in recent years seems to have become an essential component of the decisions on the transformation processes of the city and the territory. The fast change and the multiplicity of actors involved need to project the hypothesis of the project within the future to assess the likely impacts, reliability, sharing" (Secchi, 2000).

The proposed methodology and the online geographic information system (SIT/ GIS &WEBGIS) will allow all governments of the region to carry out simulations of a change of scenario for changes in land use and its impact on the state of water resources. Such a cognitive tool to support the decision-maker might affect , in the early stages, decision with respect to spatial planning, where now the parameters to keep in mind and the data to take into account apply to a plurality of issues to be addressed simultaneously that are outside the range of a single expert especially in large scale, the one of the basins and then to the regional and interregional scale (district).

A similar approach is represented by the ESPON European Spatial Planning Observation Network TIA Territorial Impact Assessment where are directly analyzed the territorial impacts of EU policies.

As suggested in the ESPON network, maps are a useful and easy way to make complex information accessible to a wide audience. This kind of tools based on the multi-scalar territorial analysis concept are therefore fundamentally useful in territorial analyses, in support of successful policy.

REFERENCES

Ippolito, A.M. (Ed.). (2012). *Il progetto di paesaggio come strumento di ricomposizione dei conflitti*. Milano, IT: Franco Angeli Editore. ISBN: 9788820409548.

Caiaffa, E. (2006). *Sistemi informativi geografici*. Roma, IT: Enea Ente per le Nuove tecnologie l'Energia e l'Ambiente. ISBN: 88-8286-140-6.

Di Giacomo, T.V. (2014). Volcanic lake basins integrated framework for landscape functionality. In C. Biscarini, A. Pierleoni, & Luigi Naselli Flores (Eds.), *Lakes: The mirrors of the Earth. Balancing ecosystem integrity and human wellbeing*. *Volume 2: Proceedings of the 15th World Lake Conference* (pp 264-267). Napoli, IT: Science4Press. ISBN: 978-88-96504-04-8 (print), ISBN: 978-88-96504-07-9 (online).

Leone A. (2011). *Ambiente e pianificazione. Analisi, processi, sostenibilità*. Milano, IT: Franco Angeli. ISBN: 9788856832778.

Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (Eds.). (1999). Geographical information systems: Principles, techniques, management and applications. Second Edition. Chichester, UK: Wiley. ISBN: 978-0-471-73545-8.

Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2010). Geographic information systems and science. Third Edition. Hoboken, NJ, USA: Wiley. ISBN: 978-0-470-94809-5.

Li, W., Goodchild, M.F., Anselin, L., & Weber, K. A. (2013). A service-oriented smart cybergis framework for data-intensive geospatial problems. In M. F. Goodchild, & S. Wang (Eds.), *CyberGIS: Fostering a new wave of geospatial discovery and innovation* (pp. 107-123). New York, NY, USA: Springer.

Pelorosso, R., Gobattoni, F., Lopez, N., & Leone, A. (2013). Verde urbano e processi ambientali: Per una progettazione di paesaggio multifunzionale. *Tema. Journal of Land Use, Mobility and Environment*, 6(1), 95-111. doi: http://dx.doi.org/10.6092/1970-9870/1418.

Ripa, M. N., Leone, A., Garnier, M., & Porto, A. L. (2006). Agricultural land use and best management practices to control nonpoint water pollution. *Environmental Management*, 38(2), 253-266. doi: 10.1007/s00267-004-0344-y.

Secchi B. (2000). *Prima lezione di urbanistica*. Bari, IT: Laterza. ISBN: 8842060607.

Wong, T.H.F., Allen, R., Brown, R.R., Deleti, A., Gangadharan, L., Gernjak, W., Jakob, C., Johnstone, P., Reeder, M., Tapper, N., Vietz, G., & Walsh, C.J. (2011). *Stormwater management in a water sensitive city: Blueprint 2011*. Melbourne, AU: Cooperative Research Centre for Water Sensitive Cities. ISBN: 9781921912009.

World Water Assessment Programme. (2012). *The United Nations World Water Development Report*. Paris, FR: UNESCO. ISBN: 978-92-3-104235-5.

WHO/UNICEF. (2013). *Progress on sanitation and drinking water. 2013 update: Joint Monitoring Programme for Water Supply and Sanitation*. Geneva, CH: World Health Organization. ISBN: 978-92-4-150539-0.

AUTHOR'S PROFILE

Tullia V. Di Giacomo

Italian Engineer graduated in Building & Architectural Engineering with final thesis on urban and landscape planning on a water sensitive planning approach to a river park project. Tutor of Urban Planning Course by Prof. C. Mattogno - "SAPIENZA" University of Rome, Engineering Faculty. At present Ph.D. Student, in Tuscia University, in territorial planning with Prof. M. N. Ripa, studying how to integrate water resources planning, water pollution modeling and geographic information system.

TeMA
Journal of
Land Use, Mobility and Environment

TeMA 1 (2015) 83-101
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2921

review paper received 4 February 2015, accepted 25 April 2015

www.tema.unina.it

How to cite item in APA format:
Pirlone F. & Candia, S. (2015). Cycle sustainability. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 83-101.
doi: http://dx.doi.org/10.6092/1970-9870/2921

CYCLE SUSTAINABILITY

FRANCESCA PIRLONE[a] , SELENA CANDIA[b]

[a] Department of Civil, Chemical and Environmental Engineering
(DICCA) - University of Genoa
e-mail: francesca.pirlone@unige.it

[b] Municipality of Genoa
e-mail: scandia@comune.genova.it

ABSTRACT

One of the main problems that affects modern cities is connected to transport/mobility. Urban transport is currently based on car use; the transition to the use of more sustainable means of transport is happening slowly. Bicycles used as main way of transport, combined with walking, it’s a successful solution for many towns to really bring traffic and congestion down. For their high density and their short time travels, towns are the best places (in comparison to long time travels as merchandise transport) to reduce the green houses gasses emitted promoting walking, cycling and public transport. For this reason the European Union is directly founding different projects that boost urban cycling. Many examples presented in this paper where collected by an European project. This project sectioned best practices and excellences in cycling as the so called cycle cities: Amsterdam, Copenhagen, Seville,...cities that have recognized the importance of cycling as a solution to traffic congestion. But how is it possible to transfer these experiences to others realities?
The scope of this article is to show the sustainability of cycling according to socio-economic (social and economic sustainability) and environmental terms (environmental sustainability).
For this reason is proposed a CBA (Cost and Benefits Analysis) methodology specific to evidence the advantages of investments in cycling made by public authorities or private companies both, to promote and realize ecological infrastructures.

KEYWORDS:
cycling, transport, cost and benefit analysis

TeMA 有关土地使用、交通和环境的杂志

TeMA 1 (2015) 83-101
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2921

review paper received 4 February 2015, accepted 25 April 2015

www.tema.unina.it

How to cite item in APA format:
Pirlone F. & Candia, S. (2015). Cycle sustainability. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 83-101.
doi: http://dx.doi.org/10.6092/1970-9870/2921

自行车出行的可持续性

FRANCESCA PIRLONE[a], SELENA CANDIA[b]

[a] Department of Civil, Chemical and Environmental Engineering
(DICCA) - University of Genoa
e-mail: francesca.pirlone@unige.it

[b] Municipality of Genoa
e-mail: scandia@comune.genova.it

摘要

影响现代城市的一个主要问题就是交通运输/流动性.城市交通现在是以使用汽车为基础，但向更可持续交通方式的转变进展缓慢. 对很多城镇来说，将自行车作为主要交通方式，并与步行相结合，是真正降低交通流量和拥堵的成功解决方案. (与货物运输行程的长时间相比)因密度高，行程时间短，城镇成为用推动步行，自行车出行和公共交通来降低温室气体排放的最佳场所. 正因如此，欧盟正直接资助能推动城市自行车出行的不同项目. 本文列举了一个欧洲项目所收集的许多例子.这个项目对自行车出行的最佳实践和优点以及所谓的自行车城市进行了划分，这些城市包括阿姆斯特丹，哥本哈根，塞维利亚等已经认识到自行车作为一种交通拥堵解决方案的重要性的城市.但这些经验能否转移到其他现实中呢？
本文的作用是从社会经济(即社会和经济可持续性)和环境(即环境可持续性)角度来展示自行车出行的可持续性.
因此，本文用成本效益分析（CBA）方法，来证明政府当局或私营企业为促进和实现生态基础设施而对自行车出行进行投资所具有的优势.

关键词
自行车出行，可持续性，交通

1 CYCLING AND TOWNS

Towns are modern society main actors. Here are concentrated the majority of habitants, commerce and trades. Inside European towns live more than 70% of the population and it is generated more than 80% of the European PIL, but the majority of these towns is not developed in a sustainable way. One of the main unsolved problems is related to mobility, that is more and more difficult and inefficient. Metropolis are rapidly growing – United Nations say that within the 2050, world population will reach 9 billion of people instead of 7 – and so there is an increasing number of people that need to move every day. "That travel is a derived demand and not an activity that people wish to undertake for its own sake" (Banister, 2008). Urban mobility is based on private car use which are usually alimented with carbon fuels. The gradual change through soft mobility ways of transport is slowing happening.

"Even though there is not yet a unique definition, we can argue that soft mobility (pedestrian, cycle and other not motorized displacements) is a zero impact mobility trying to be alternative to the cars use" (La Rocca, 2010). City as Warsaw, Marseille, Rome, Paris[1] suffer from chronical traffic congestion that costs 80 billion of euro every year. Traditional transport is not only an economical problem, but one of the main causes of climate changings. Towns also produce over 70% of global energy-related CO_2 emissions[2]. Cycling as preferential way of transport inside towns - combined with the creation of new pedestrian zones - is an efficient solution to reduce vehicular traffic. Towns for their high density are characterized by short transfers, so pedestrian, cycling and walking could really be considered as good way of transport to go to move every day. "The majority of nonwork trips are within walking or cycling distance and are therefore of interest to the physical activity, air quality, and transportation planning fields" (Saelens et al., 2003).

The document Europe 2020 - A European strategy for smart, sustainable and inclusive growth underlines the importance to develop sustainable and modern systems of transport inside Europe. For this reason many urban cycling projects were funded directly the European Union. Many examples presented in this article where collected thanks to one of these European projects[3], that selected best practices and excellences of cycle cities – as Amsterdam, Copenhagen, London, Seville, ... -. A cycle city is a town where cycling is promoted and supported in order to avoid traffic congestion. But how is it possible to transfer these good experiences to others realities?

Cost Benefit Analysis (CBA) is commonly considered as an ex-ante evaluation tool to address the decision for new infrastructures. "The CBA has become a widely used instrument for the appraisal and evaluation of large infrastructure projects in many countries" (Haezendonck, 2007; Mackie, 2010; May et al., 2008; Odgaard et al., 2005; Rotaris et al., 2010; Vickerman, 2000). But even if this analysis has already shown its benefits to support new travel infrastructures, as roads, railway lines, tunnels, it's still rarely used to address investments in cycling.

In this paper the authors[4] want to demonstrate the convenience to adopt this methodology for public and private investments in cycling. The analysis proposed considers costs and benefits related both to social or environmental aspects and it underlines the advantages that come from the realization and promotion of cycling thanks to public and private joint investments. Many examples and indications are later given to reach a perfect balance between this two form of investment. Obviously, main benefits are related to health and environmental aspects (air pollution, CO_2 production, land use, …). From conclusive CBA data it is

1 Top 10 most congested cities in Europe, The Telegraph, UK 2015.

2 Cities, towns & Renewable Energy, International Energy Agency, OECD/IEA 2009.

3 CycleCities project, INTERREG IVC Innovation & Environment - Regions of Europe sharing solutions, involved 8 partners.

4 Selena Candia has done an analysis about public investments in cycling thanks to an European project. The author developed the methodology proposed in this article after doing many researches on the existing best practices about cost-benefit analysis in public and private investments. Francesca Pirlone has done an analysis about private investment in Cycling in European Countries. The author enhanced the CBA methodology considering costs, general benefits and environmental impacts connected to public and private investments in infrastructures. This CBA methodology is a useful tool for local transport plans and policies.

evident the importance and the convenience to invest in cycling: bicycles are less expensive (1 Km of new car ways correspond to 110 Km of new bicycles lanes) and they are cleaner (zero emission) compared with other means of transport. Cycle cities are more liveable and a synonymous of quality.

2 COST-BENEFIT ANALYSIS FOR PRIVATE AND PUBLIC INVESTMENT IN CYCLING

A world widely used systematic process for calculating and comparing gains (benefits) and costs of projects, decisions and policies is the Cost Benefit Analysis, this tool is used in order to determine if it is a sound investment (justification / feasibility) and to see how it compares with alternative projects (ranking / priority assignment). Since there is a long history of evaluation of major transport projects such as motorways, railways, etc. CBA may also be proven a helpful tool to demonstrate the potential of cycling.

In particular to analyze investments in cycling it have been used a SCBA, Social Cost Benefit Analysis that can include soft factors besides hard effects reflected by real behavior and real economic value. "Social Cost Benefit Analyses (SCBA) are used in many western countries as evaluation tool for infrastructure projects ex ante" (Mouter et al., 2013). Making a SCBA gives insight to policymakers and the public into the costs and benefits of an infrastructure project or several alternatives. Not only the simple costs of building a road, bridge or rail track are included but also soft costs such as damage to nature, pollution and accidents are taken into account. The SCBA appeared in the literature in 2000 as a renewed version of the well-known CBA method as a result of the Dutch OEEI guideline[5].

"Despite all the theoretical studies performed on the types of information policy makers can process, the need for transparency and for an active multi-actor involvement in the evaluation and decision process has become politically essential and explains why SCBA became successful" (Haezendonck, 2007). The SCBA includes different assessment procedures and in particular it integrate some participation techniques to include stakeholders in the decision-making process. On the benefit side a SCBA calculates the benefits of a certain infrastructure project to society in terms of welfare. These benefits include travel time gains, better accessibility, safer traffic environment, agglomeration effects and so on.

"In the Academic spheres as well as in public policy the Societal Cost Benefit Analysis can count on some critics as well" (Beukers et al., 2012). Those critics mainly focus on the problems of quantifying softfactors due to an infrastructure project, such as effects on nature. However, translating the soft factors into money makes it possible to involve them into the analysis so that a decision is far better supported. In summary, a SCBA attempts to measure the positive or negative consequences of a project, which may include: effects on users or participants, effects on non-users or non-participants, externality effects and Option value or other social benefits.

To do a correct CB analysis – for public or private investments in cycling - is important to follow an accurate planning composed by different steps: problem analysis; formulation of alternative solutions; identification, quantification and monetization of effects; comparison between cost and benefit; sensitivity analysis and final decision. This CBA planning is reported in figure 1. The adoption of cycling can have significant impact in mitigating a variety of the costs associated both with the usage of public and private transportation methods. Indicatively cycling can play an important role in saving time and money. A new bicycle could cost around 150€, for a new car are necessary 20.000€. Bicycles don't have any maintenance costs, cars' maintenance costs are really high: fixed cost as the insurance and operational costs as fuel, parking, highway costs.

[5] OEEI Onderzoeksprogramma Economische Effecten Infrastructuur - Research Programme on the Economic Impacts of Infrastructure – Netherlands.

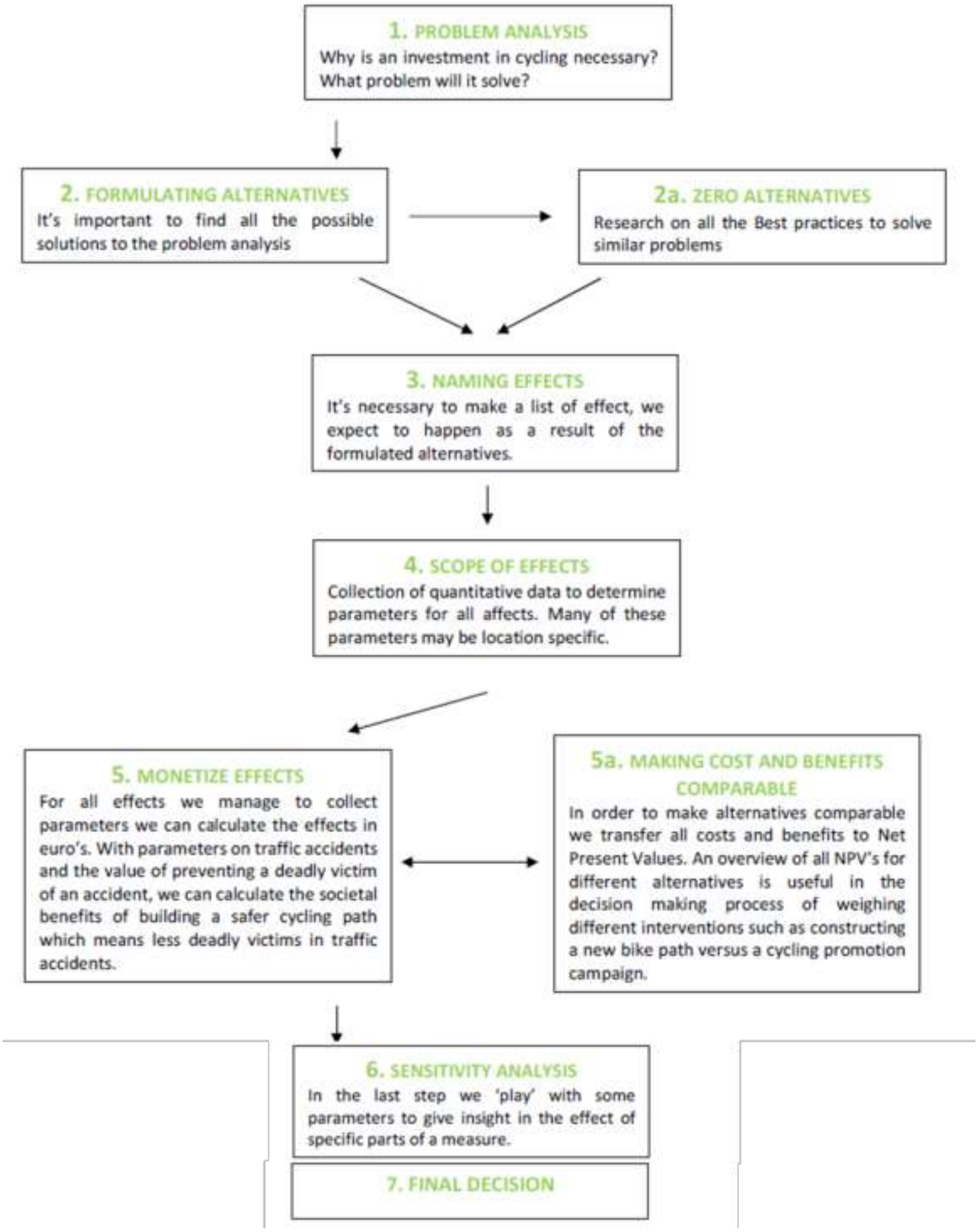


Fig.1 CBA analysis procedure

The operational costs for a small car are estimated around 8.500€ - considering 15.000 km/year -. To this amount a car owner have to had 1.800 € of fixed costs. The city of Hamburg with the project We are the traffic (see figure 2) showed that cycling instead of car driving in ten years could make you save more than37.000€. All these costs related to cycling are not comparable with the costs needed to build new roads, tunnels, railways, (see figure 3).

Traffic and congestion are the main causes that could really extended the costs prolonging everyday trips. Inside Mexico City center to do 20 kilometers it could take more than four hours, this is really a contradiction because it's possible to cover the same distance in less time on foot.

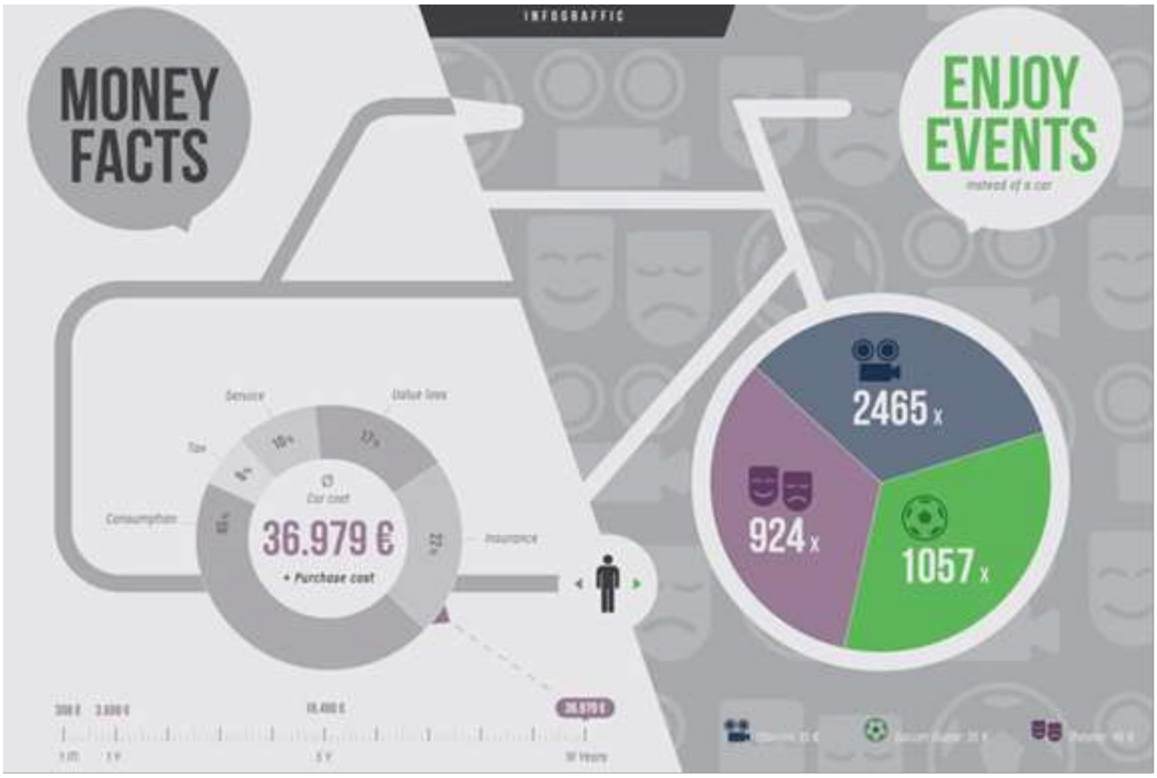


Fig. 2 We are the traffic cycling campaign in Hamburg

1 KM OF…….	IS EQUIVALENT TO N°Km OF BIKEWAY
Rail	29 Km
Road	110 Km
Bus Way	138 Km
Road with tunnels	324 Km
Underground rail	533 Km

Fig.3 Comparison between cycle infrastructure cost and the infrastructure cost of the other mean of transport

Traffic congestion costs Europe about 1% of Gross Domestic Product (GDP) every year. Different cities have already adopted drastic measures: in Sigapore each day could enter a pre-determined number of cars, many Italian towns have a car-free center,… Cycling should be treated as a complement to public transportation rather than a competitor. To this end measures that facilitate the integration of both methods of transportation can have an important role. A successful policy in this case would have significant impact on the effectiveness and efficiency of both methods of transportation. Short trips would become faster, while the ability to use public transportation would allow for the bicycle to be used for more distant destinations, thus increasing its flexibility. This complementarity would elevate the profile of both transportation methods and make them more attractive to a larger part of the population, especially the youngest segments.
To do a correct CBA is also important to know which are the drivers or the inhibitors that can facilitate or prevent investments in cycling (see figure 4). First of all is necessary a solid collaboration between national and local Authorities and private companies. Public administration have to give the right example. Which could mean financially invest in cycling infrastructure themselves, but it could also be by providing a Master plan on how cycling should get a more important position in a city’s infrastructure.

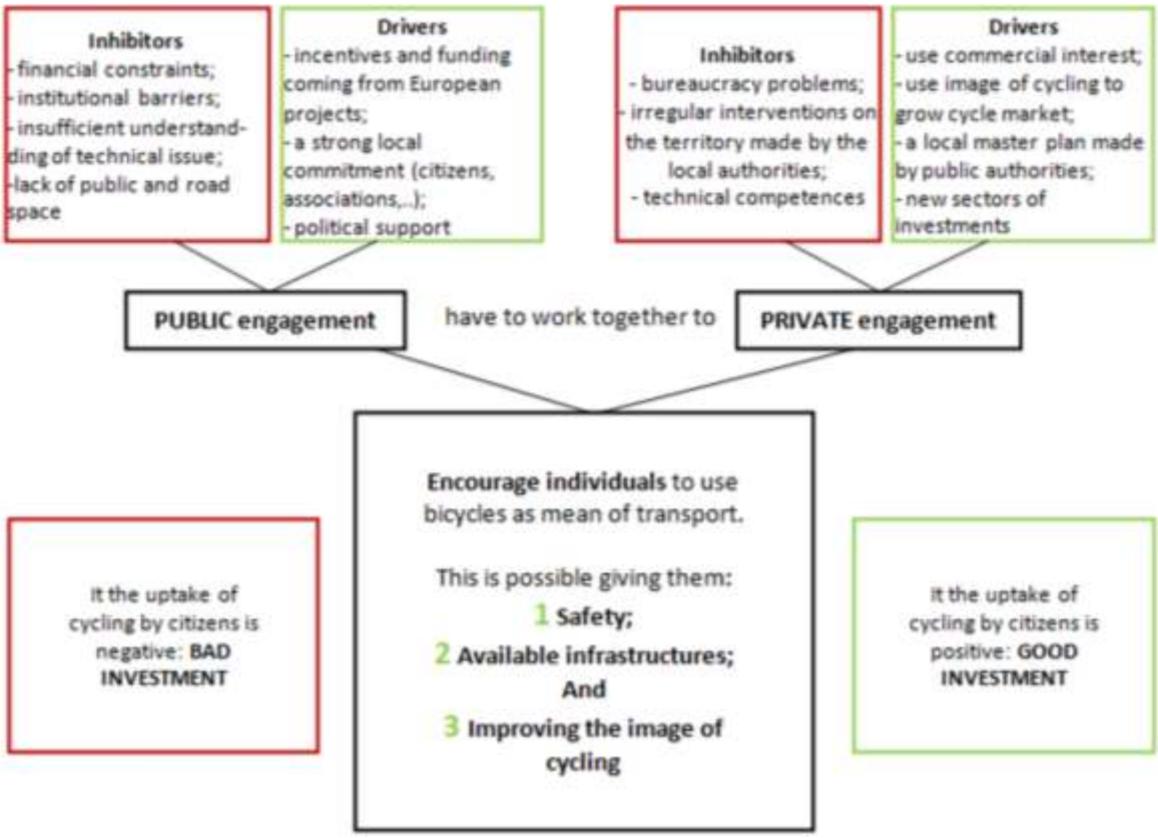


Fig. 4 Drivers or inhibitors that can facilitate or prevent investments in cycling

It's also important to set out a national/local approach to prioritize future investments in capital and revenue spend on cycling, and challenges policy makers to ensure that programs are in place to influence, enable and encourage individuals, families and communities to take part in physical activity and adopt active travel choices. An important driver or inhibitor is connected to the portion of population that will shift towards cycling. Generally if a low uptake is expected, then the cost will probably outweigh the benefits, and thus the investment might not be undertaken.

3 CYCLING COSTS

In Italy there aren't many cycle cities. Public Authorities and administrations are not always aware about cycling's benefits or cycling is not seen as a priority. There is the necessity to spread the reasons that make bicycles important to reduce traffic congestion and pollution for short travels, contributing also to people health. Cycling costs are related to cycling infrastructures/activities. In this paper these costs have been studied. These are the costs associated with the initial construction of an infrastructure and there are expenses that occur only once. They can range from relatively low (e.g. the installation of signs and traffic management equipment) to intermediate (e.g. construction of bike lanes on the existing road network) to high (e.g. construction of bicycle tracks and off-road paths). Other costs are related to maintenance and operational expenses.

Firstly are here reported the infrastructure costs. To understand these costs it's important to have a general description about the type of infrastructure[6]. Infrastructure costs has been divided into four main categories: Travel infrastructure for cycling (A); Bike parking and end of trip facilities (B); Integration of bicycling with public transport (C); Bike sharing system (D).

[6] Type of infrastructures starting from The national Cycle Manual edited by National Transport Authority of Ireland 2014.

The first category, travel infrastructures for cycling, includes infrastructures upon which bicycles can travel and other measures (through infrastructures) that facilitate the flow of cycling traffic. Within this first sub category has been distinguished two kinds of travel infrastructures differentiated by the existence or not of a physical separation of the cycling path from the rest of the road used by other vehicles. Travel infrastructures without physical separation are called Mixed Traffic; they are paths where cycling traffic is mixed with motorized traffic, or where there is no physical obstacle for crossing over between normal street and cycling path. Examples of Mixed Traffic are: one road bicycle lanes; two-way travel on one-way streets; shared bus/bike lanes; bicycle boulevards; colored lanes; shared lane markings; advanced stop lines (see figure 5).

MIXED TRAFIC	EUROS	UNIT
Bicycle lane on bus lane	51,88	Per meter
Pavement marking	7,59	Per meter
Cycle logo (each)	38,91	Each

Fig.5 Costs of different types of infrastructure in Europe in 2014

Travel infrastructures with physical separation are called Separated Traffic, they are paths where cycling traffic is completely separated from motorized traffic. This implies a physical obstacle that cars cannot cross easily or at least without noticing it. Examples of Separated Traffic are: cycle tracks and off-street paths (see figure 6).

SEPARATED TRAFIC	EUROS	UNIT
Bicycle lane with major junctions	950,82	Per meter (wide 1,5m)
Bicycle lane with simple junctions	345,72	Per meter (wide 1,5m)
Raised white line	17,05	Per meter

Fig.6 Costs of different types of infrastructure in Europe in 2014

Other measures, that facilitate the flow of cycling traffic, are infrastructures where various types of lanes/tracks facilitate the usage of bicycles by citizens. However those routes are not the only measures that can have an impact on the usage of bicycles, their effectiveness and (as a result) the potential for a shift for citizens from motorized traffic to cycling. Indicative examples of this type of investments are: bicycle phases/traffic signals, traffic calming methodologies, way finding signage and techniques to shorten cyclists' routes. All this category includes traffic arrangements that facilitate cycling traffic especially in intersections and involves the construction of cut-through that provide cyclists with more direct ways than motor vehicles (see figure 7).

OTHER MEASURES	EUROS	UNIT
Traffic light	4.447,30	each
Bike route signage	127,46	each
Raised white line	17,05	Per meter
Traffic calming / managed area	345,72	

Fig.7 Costs of different types of infrastructure in Europe in 2014

The existence of the necessary lanes and routes examined in the previous pages is of significant importance when individuals consider using a bicycle for their trips (both work related commuting as well as leisure). They are not however the only factor. Of similar importance are the so called End-of-trip facilities. These are infrastructures that cyclists can use when they have reached their destination.

In this vein a categorization that can be made is the following: unsheltered, sheltered, guarded, bike parking; bike lookers; bike rentals; bike repairs; bike washer; showers and changing room.

On a per parking space basis, unprotected outdoor bicycle stands or racks are the cheapest to provide. The only significant cost is the cost of the stands themselves. A single inverted 'U' or post-and-ring stand, which accommodates two bicycles, costs roughly €100-€150 or €50-€75 per bicycle parking space (City of Ann Arbor, 2008). A canopy or shelter for weather protection for twenty bicycles could cost anywhere between €5,000 and €15,000 (€250 to €750 per bicycle), depending on the quality of the design and materials used (Bikeoff, 2008). Bicycle lockers are considerably more expensive. A single bicycle locker can cost from €1,000 to €2,500, depending on the model (see figure 8).

END OF TRIP FACILITIES	EUROS	UNIT
Unsheltered bike parking	100	Per bicycle
Sheltered bike parking	300	Per bicycle
Bike lockers	1500	Per bicycle

Fig.8 Costs of end of trip facilities, City of Ann Arbor Bike Parking for Your Business, 2008

Other infrastructure costs are related to the realization of a new bike sharing system. A bicycle sharing, or bike share scheme, is a service in which bicycles are made available for shared use to individuals on a very short term basis. Each bicycle cost is about €1,000, and the annual operating cost per bike was €1,860[7].

There are other costs related to cycling differently from the over mentioned cycling infrastructure costs. These expenses could be divided into two categories: promotion measures including information, formation and marketing also using new technologies (smartphone app, virtual maps,…) and organization managerial measures including financing.

After constructing any cycling infrastructure and releasing it for usage the maintenance costs have to be considered to prevent the continuous and gradual degradation. This degradation is a combined result due to the usage and other environmental factors. It's important to ensure and to maintain an acceptable level all physical and qualitative properties of an infrastructure making periodically repair. These periodic reparations involve different maintenance costs that are around 1700 €/(km*year)[8]. Some types of investment have also operational costs not only maintenance costs. These cost are related to the normal infrastructure operation. Examples of operational costs are: the salaries of personnel operating bike-sharing system, the energy consumption of lights and of traffic lights. Operational costs for traffic lights, street lights and the like are marginal compared to initial infrastructure investment and maintenance costs.

2.1 PUBLIC AND PRIVATE INVESTMENTS: EXAMPLES AND GUIDE LINES

The over mentioned cycling costs could be effort by Public Authorities, Private companies or private and public subjects in partnership. Private investments in cycling infrastructure are more and more substantial; in Europe and in the North of America exist cycle lanes or bike-sharing programs entirely financed by private investors. Here below are reported different examples to understand how public and private could work together. The Velocity 2025 (Manchester UK) Master Plan from the Transport for Greater Manchester

[7] Bike Share Under Consideration, Alexandria Gazette Packet Retrieved May 14, 2011.

[8] PSC, Realizzazione e manutenzione straordinaria piste ciclabili, Comune di Firenze 2010.

Fig.9 London Barclays Hire

Committee shows how public and private parties can cooperate in stimulating cycling. The Plan actively engages the private sector to invest in cycling infrastructure. The Barclays Cycle Hire (London, UK) is a good example of combination of public and private investment. Initiated by the municipal government the private investment involved is substantial: Barclays contributed 25 million pounds in exchange for being the name carrier of the prestigious project (see figure 9).

"In countries with a high popularity of cycling like the Netherlands or the Scandinavian countries, cyclists are a very important group of customers for retailers, especially in the city center" (Kastrup, 2013). Bad or missing parking facilities for bikes are an important barrier for people to take their bike for a shopping trip. This should be an incentive for retailers or developers of retail real estate to take care of enough parking facilities for bicycles around the shopping area or in front of shops. Private companies in general could stimulate cycling by investing in parking facilities for bicycles at their own location. Besides stimulating their own employees to take up their bicycle for commuting trips they can stimulate visitors to come by bike as well. "Investments in physical facilities at the workplace that offer better comfort to cycling commuters are called investments in a Bicycle-Oriented-Design" (Phyllis et al., 2010). Bad or missing facilities at the end of a commuting trip can be a major barrier towards cycling for commuters. So the other way around, investments of the employer in a bicycle-oriented-design could encourage the employees to take up their bicycle to work. Opening up bicycle shops therefore can be seen as private investments in cycling infrastructure, in the end even influencing peoples travel mode choice towards cycling. The opportunity of fixing defects like a flat tire in close proximity to a cyclists route makes it far more comfortable to cycle around the city. In Europe, local governments exploit still 27% of the existing bike sharing systems. "However, the future of bike-sharing is to private (or public-private) initiatives as new business models are emerging" (Parkes et al., 2013). The most efficient way to involve private investment is to give to private companies the possibility to show their logos and advertisements for free in public spaces in exchange of their investment in cycle infrastructures (at the bike sharing- stations as for London Barclays Cycle Hire example).

Local governments could involve private investors in several ways according to:

- the advertising model: a private company builds the infrastructure and provides the bike fleet for a bike sharing program in order to have the right advertisements on the streets (at the bike sharing-stations). Local governments mostly exploit the system;
- the sponsor model: another advertisement based business model to realize bike sharing programs. In this case, the local government is the initiator of the program but private companies do (most of) the investment. The program is often named after the sponsor, but exploited by the local government.

Sponsoring professional cycling teams by bicycle manufacturers, or other companies, can be seen as private investment in cycling as well. Reason for sponsoring a cycling team is simple: getting good publicity and eventually growing their market share. There are also private investments connected to health insurances. For employers promoting cycling towards their employees could be a very good economic investment.

The health and wellbeing program of the American bicycle company Quality Bike Products (QBP) shows that offering financial incentives towards employees to commute by bike, results in significant health effects and appurtenant financial benefits. The company offered their employees an account of €110 to buy QBP products and paid € 45.000 on commuter rewards to cycling commuters every year. The program resulted in a 4.4% reduction in health costs associated with a saving of €170.000 over three years.

But what Municipalities have to do to stimulate these private investment in cycling? (see figure 10)

- an active campaign on cycling can encourage private parties to start investing in cycling;
- giving the right example and making a Master Plan on how cycling should get a more important position as a city's infrastructure;
- think about different ways of financing public cycling infrastructure, using commercial interest of private companies (like the right to advertise in public space);
- keep on boosting cycling even if there are political changes in the Public Administration.

First of all, when private companies investments in cycling are requested, Public Authorities have to capture their attention supporting a significant campaign to promote cycling as a daily mean of transport. This could mean financially investing in cycling infrastructure themselves, but it could also be by providing a Master plan on how cycling should get a more important position in a city's infrastructure. Private companies will probably follow public efforts to improve the infrastructure.

When the cycling infrastructure is expanded by public effort, resulting in an increase of cyclists, private companies will follow by investing in parking facilities for instance because people will start to reach their location by bike. Commercial interests can be used to co-finance cycling infrastructure. Sponsoring a bike sharing system has two major benefits for private companies.

First of all it provides advertisement space in the public environment. Besides that, supporting a sustainable transport project is good for the image of a company, which is quite a driver in these times when consumers seem to value Corporate Social Responsibility. Moreover parking facilities at shopping centers or streets should be in the interest of retailers because cyclist are good customers.

4 CYCLING BENEFITS

"The benefits of such cycling are potentially extensive – reduced local noise and air pollution, decrease in emissions of greenhouse gases, improved safety, better fitness levels of the population, as well as changes which are more difficult to quantify such as greater sociability of the urban environment, increased freedoms for children to use the environment and an overall improvement in urban quality of life" (Tight, 2011).

The main socioeconomic benefit of cycling is on the health side. Frequent use of the bicycle for commuting as well as leisure activities is a very good way to have regular physical activity. This reduces symptoms of a sedentary lifestyle, increases fitness and improves overall health. The gains for society come in form of reduced healthcare costs, which can mitigate most of the investment costs if a significant modal shift is achieved. A Danish study proved that women bikers live 2/3 years more and men bikers 4/5. Moreover Tour de France participants live around 8 years more than other athletes (according to a study published on The International SportMed Journal).

Another important aspect is connected to environment, transportation choices contribute to global warming and affect the environment. Three quarters of the volume of CO_2 emissions from land transport operations are produced by road traffic. The greenhouse-gas emissions from air transport and international sea transport must also be taken into account. They are responsible for about 3% (air transport) and 4% (sea transport), respectively, of the CO_2 emissions in the EU-27. In other to measure the real benefits of cycling on the environmental, this research developed a specific methodology to determinate the environmental impacts related to transport systems. The assessment of environmental effects requires identification of:

- thematic areas of influence;
- parameters per thematic area;
- indicators per parameter or thematic area;
- indicators assessment.

Typology of cycling infrastructure	Public investment in cycling		Private investment in cycling	Combination of public and private investment
Travel infrastructures	mixed trafic	On-road bicycle lanes. A stripe separating bicycles from other vehicles.These lanes occupay part of existing roadway	The "Velocity"2025 (Manchester UK) master plan from the Transport for Greater Manchester Committee shows how public and private parties can cooperate in stimulating cycling. The plan actively engages the private sector to invest in cycling infrastructure. The "Barclays Cycle Hire" (London, UK) is a good example of combination of public and private investment. Initiated by the municipal government the private investment involved is substantial: Barclays (an important bank in the UK) contributed 25 million pounds in exchange for being the name carrier of the prestigious project.	Mostly the local government is the initiator of the program but the investment is done by private companies in exchange for advertisement or for being name carrier of the project. What Municipalities have to do to stimulate private investment in cycling? - An active campaign on cycling can encourage private parties to start investing in cycling; - Giving the right example and making a master plan on how cycling should get a more important position as a city's infrastructure; - Think about different ways of financing public cycling infrastructure, using commercial interest of private companies (like the right to advertise in public space); - Keep on boosting cycling even if there are political changes in the public administration.
		Two way travel on one-way streets. In this case bycicle can travel in the opposite direction in one-way streets.		
		Shared bus/bike lanes. Bicycles are allowed to travel on bus lanes.		
		Bicycle Boulevards. These are signed bicycle routes usually on low-traffic streets.		
		Colored lanes. Bicicle lanes more visible thank to the use of color.		
		Shared lane markings. Lanes where both bicycles and cars can travel.		
		Advanced stop lines. It's a marked "box" where cyclist can wait when traffic lights are red.		
	separated traffic	Cycle tracks. There is a physical separation between motorized traffic and cyclist instead of a simple stripe.		
		Off street paths. These are also tracks that are completely separated from motor vehicle traffic. They are paved and usually pedestrian travel is not allowed on them.		
	other infrastructures	Traffic signals. Signals dedicated to cyclist.		
		Way finding signage. Sings to help cyclist to find directions for prominent estination.		
		Techniques to shorten cyclist' routes. This category includes traffic arrangements that facilitate cycling traffic especially in intersection.		

Typology of cycling infrastructure	Public investment in cycling	Private investment in cycling	Combination of public and private investment
Bike parking and end of trip facilities	bike parking bicycle rentals bycicle repairs bycicle washer showers and change rooms	bike parking bicycle rentals bicycle repairs bicycle washer showers and change rooms	In this kind of investment the private is the predominant part. These end of trip facilities can create new jobs (bicycle rentals, repairs, washers…) or can be done by enterprises to get better the condition of their employees (showers, bike parking,…)
Integration of cycling with public transportation	Extensive network of parking spots for bicycles close to metro and railway station as well as central bus hub.	Private advertisment in interconnation hot spots.	This kind of investment is typically public, but integrating bicycles with other mean of transports, municipalities can save money for example investing less in busses.
Bike sharing	Bike sharing system and network. At multiple locations throughout a city there are bike-sharing station where people can grab a bike on as-needed basis.	In Europe, still 27% of the existing bike-sharing system is exploited by local governments. According to Parkers et al. The future of bike sharing is to private, or public-private initiatives.	Mostly the local government is the initiator of the program but the investment is done by private companies in exchange for advertisement.
Industry alliances		On the national but also on the European level, bike manufacturers unite themselves in industry networks.	More cyclists mean more bikes and more bikes are good for business. If cycling levels in Europe matched those of Denmark, we would sell 30 million more bikes per year. But even by doubling cycling in Europe, we could increase the market by 10 million bikes.
Professional cycling		Sponsoring professional cycling teams by bicycle manufacturers, or other companies, can be seen as private investment in cycling.	Reason for sponsoring a cycling team is simple: getting good publicity and eventually growing their market share. But why these investments are interesting in the light of investment in cycling in general is the chance of growing the total market for bicycles.
Health insurances' investments		Promoting cycling towards their clients could be an interesting investment for insurance companies.	This kind of investment is typically private, but also public administrations could benefit of it, moreover in Countries where the Health system is guaranteed by National governments.

Fig.10 Integration and synthesis of data analyzed about public and private investments

The first two steps of this methodology are important to identify all the possible environmental impacts caused by transport. This identification starts with an accurate research work on a lot of scientific documents. Step 2 involves quantification of as many as possible of the indicators emerged from previous research stage in order to establish a data basis of unit prices for cycling for each EU country. After the quantification of indicators is possible to compare and to assess all the different means of transport from an environmental point of view.

The five thematic areas of interest, identified by this research- direct or indirect responsible for climate changing - are: Energy use, Air quality-CO_2 production, Noise, Quality of urban space and Land use. For each thematic area, specific parameters and indicators have been identified. This is necessary to correctly asses the real impact of different mean of transport on each thematic area and to give a final evaluation.

The first thematic area is Energy use. The energy exploited by the transportation sector includes energy consumed in moving people and goods by road, rail, air,…. In the IEO2013 (International Energy Outlook) reference case, world energy consumption in the transportation sector increases by an average of 1.1 percent per year. Petroleum and other liquid fuels are the most important component of transportation sector energy use throughout the projection.

The second category is Air quality. Smog hanging over cities is the most familiar and obvious form of Air pollution. But there are different kinds (CO_2, PM_{10}, NO_x, SO_2,..) of pollution—some visible, some invisible—that contribute to global warming. Air pollution harms human health and the environment. In Europe, emissions of many air pollutants have decreased substantially over the past decades, resulting in improved air quality across the region. However, air pollutant concentrations are still too high and air quality problems persist. Environmental Noise pollution is the third thematic area and it relates to ambient sound levels beyond the comfort levels as caused by traffic, construction, industrial, as well as some recreational activities. It can aggravate serious direct as well as indirect health effects. Night-time effects can differ significantly from day time impacts. According to a European Union (EU) publication: about 40% of the population in EU countries is exposed to road traffic noise at levels exceeding 55 db(A); 20% is exposed to levels exceeding 65 dB(A) during the daytime and more than 30% is exposed to levels exceeding 55 dB(A) at night.

With the category Quality of urban spaces are gathered together two different sub-categories: Transport safety and Transport accessibility. The last impact considered is Land use that stands for the space (square meters) occupied by each mean of transport. Then measurable indicators have been found for each urban mean of transport according to the over mentioned thematic area (see figure 11). This process is very important to compare the final direct impact of each mean that derives from the total value obtain considering all the areas. The results obtained demonstrate that bicycles and pedestrians are the best way of transport in terms of almost all the thematic areas - energy use, greenhouse gasses, air quality, noise and land use –except for safety. The cause is the high mortality of cyclist in comparison to the other way of transport. But this negative result could be easily changed creating new cycle lanes, signals and educating both cyclist and car drivers.

This research had also analyses different existing methodologies to assess environmental impacts connected to each way of transport. Cycling is really good for the environment: bicycles don’t produce pollution or noise and are a good solution to traffic congestion. Here below are reported two of this methodologies: the GEF and the Evaluating the environmental effects of transportation modes using an integrated methodology and an application.

The GEF developed a manual detailing specific methodologies for calculating the Green Houses Gases (GHG) impacts of energy efficiency, renewable energy, and clean energy technology projects.

			Mean of Trasport				
Environmental impacts	**Parameters**	**Indicators**	**tram**	**bus**	**car**	**bicycle**	**pedestrians**
5.2.1 Energy Use	Typology and quantitative of energy used by each mean of transport	%Fuel used	x	25 l fluel oil/ 100 Km 0,5 l / person 100 Km (avarage capacity 50 people)	7 l fluel/100 Km	x	x
		%Energy from different sources used	5 kwh/km 0,0025 Kwh / person Km (avarage capacity 2000	1 kwh/km 0,02 Kwh / person Km (avarage capacity 50 people)	0,2 kwh/Km	x	x
5.2.2 Green House Gasses	CO_2 introduce in the environment by each mean of transport	% CO_2	33g/person Km	75 g/person Km	237 g/Km	x	x
5.2.3 Air Quality	Analisys of the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere	% PM_{10} ,	x	0,75 g/Km	diesel 0,068 g/km petrol 0,0171 g/km	x	x
		% CO	x	4 g/Km	diesel 0,97 g/km petrol 1,55 g/km	x	x
		% NOx	x	12,5 g/Km	diesel 0,202 g/km petrol 0,07 g/km	x	x
5.2.4 Noise	Analysis of the disturbing or excessive noise that may harm the activity or balance of human or animal life.	n°dB day and intensity (max 55dB)	45 dB	80 dB	70 dB	35 dB	30 dB
		n°dB night and intensity (max 40dB)	45 dB	80dB	70 dB	35 dB	30 dB
5.2.5 Quality of Urban Spaces	Safety	% mortality	0,3 death each billion of km	0,4 death each billion of Km	3,1 death each billion of Km	44,6 death each billion of Km	54,2 death each billion of Km
	Funtionality/Accecibility	% of use in Europe	pubblic trasport 22%		53,00%	7,00%	13,00%
	Upkeen services	cost of upkeen services for infrastructures in a year	not found	8.500 €/(km*year)	8.500 €/(km*year)	1700 €/(km*year)	1300 €/(km*year)
5.2.6 Land Use	Modification of the environment couse to trasportation needs	n° square meters occupied for a km of mean of transport	3000 mq/km (doubble lane)	10000 mq/Km (doubble lane)	10000 mq/Km (doubble lane)	3000 mq/km (doubble lane)	2500 mq/Km (dobble sidewalk)
		n° square meters for services connected to each mean of transport	81 mq*1 tram	38 mq*1 bus	12,5 mq*1 car	0,83 mq* 1 bike	0,5 mq*1 pedestrian

Fig.11 For each thematic area this research produced measurable indicators

This new Manual provides the first methodology designed specifically for projects in the transportation sector. The GEF models are designed to develop ex-ante estimations of the GHG impacts of transport interventions (projects) as accurately as possible, without requiring data so exacting that it discourages investment in the sector.

The methodology provides uniformity in the calculations and assumptions used to estimate the GHG impact over a very diverse array of potential projects. These include projects that: improve the efficiency of transportation vehicles and fuels; improve public and non-motorized transportation modes; price and manage transport systems more efficiently; train drivers in eco-driving; package multiple strategies as comprehensive, integrated implementation packages.

Another methodology to understand transport's environmental impact is reported in a research[9] done by the Department of Industrial Engineering inside the Technical University of Istanbul. Measuring the environmental effects of transportation modes may be a complex process because of the different criteria which approach to the subject from different aspects. However, the criteria that contain uncertainties or cannot be given precisely are usually expressed in linguistic terms by decision makers.

The methodology proposed by the Department of Industrial Engineering of Istanbul, uses a mathematical procedure called fuzzy logic for determining the weights of each criteria. "The term fuzzy logic is used to describe an imprecise logical system, FL, in which the truth-values are fuzzy subsets of the unit interval with linguistic labels such as true, false, not true, very true, quite true, not very true and not very false, etc" (Zadeh, 1975). The Department of Industrial Engineering connects different ways of transport (road, railway, sea, air, multimodal) to different environmental categories: noise, emission reduction, effects on open land, undesirable view, safety, energy resources utilization, transportation capacity of the vehicle, infrastructure of the transportation network, seasonal affect.

Then to find the best way of transport (in environmental terms) this methodology uses the fuzzy logic to give a weight to the abovementioned categories. Then it put in relation this results with all the possible alternatives of mean of transport for a specific travel. To link criteria to alternatives the Department of

[9] Evaluating the environmental effects of transportation modes using an integrated methodology and an application.

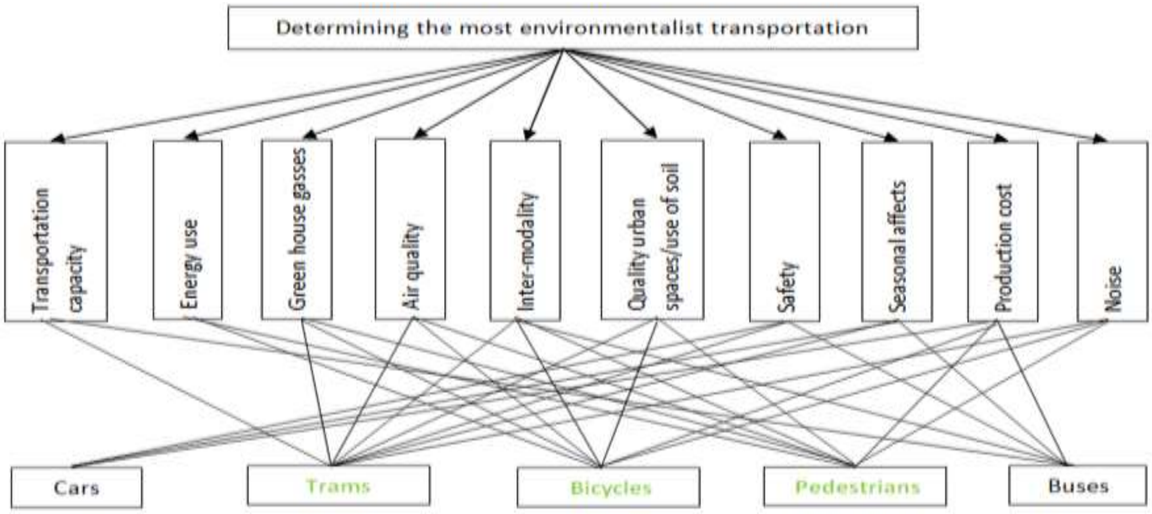


Fig. 12 Hierarchical structure of the criteria and alternatives to determinate the most environmentalist transportation at urban scale

Industrial Engineering's methodology uses a neural network. "The field of transport studies has seen an explosion of interest in neural networks in the 1990s.This can been seen as part of a general pattern of increased use of artificial intelligence techniques in transport" (Kirby and Parker, 1994). This paper adapts this methodology to an urban scale. The research adds new categories (according to the environmental thematic area reported in this chapter) to the Department of Industrial Engineering's methodology: Quality of urban spaces and Land use. From figure 12 is clear that the most environmentalist transportation at urban scale are cycling and walking.

5 CBA ASSESMENT AND CYCLING RECOMMENDATIONS

After reporting cycling costs and benefits, it's possible to precede with the CBA assessment. Cycling networks are generally good for the economy. Calculating all internal and external benefits of cycling together, based on 7,4% of use of the bicycle in Europe, and adding the turnover of related industries, ECF estimates the number to be well above € 200 billion annually, or more than € 400 for every person that lives in the EU. The evidence demonstrates that investments in cycling infrastructure make good economic sense as a cost-effective way to enhance shopping districts and communities, generate tourism and support business. This research reports two examples (one from Denmark and the other from the Netherlands) to assess investment in cycling. In the first study, unit prices are connected to expected effects; different parameters are considered as time, safety, health,…(see figure 13). Using data collected on those parameters it was possible to calculate average costs (benefits) per kilometer for cycling. However this approach is limited by the fact that for some cases no model exists that can perform such calculations. Cycling costs are separated into internal and external. The distinction is similar to the distinction between direct and indirect costs. Therefore, internal costs are the ones that affect the cyclist's decision process, because the directly affect him/her. On the contrary external costs are the ones creating externalities to third persons (for example a better quality of air to breath). It is assumed that these costs (benefits) do not enter the cyclists' decision process. The Danish study shows that the unit cost for each kilometer done by bike is 0.60, instead the cost for each kilometer done by car – driving at 50 km/h –is 3.74.

Bicycle kilometer is a Dutch web tool for making simple Cost Benefit Analyses for investment in cycling. Besides the comparison with car traffic, these Dutch figures also allow us to compare the bicycle with travelling by public transport.

EFFECT FOR THE ECONOMIC CBA	METHODOLOGY TO QUANTIFY TRAFFIC EFFECTS	DATA REQUIREMENT
Vehicle operating costs	Change in vehicle kilometer by mode, i.e. for different motorized vehicles, public transportation and bicycles.	Traffic counts and/or modeling
Time cost	Change in transport time by transport mode	Traffic counts and/or modeling
Accident cost	Change in the number of accidents with and without bicycles involved.	Accident registrations, traffic counts and/or modeling.
Pollution and externalities	Change in vehicle kilometers for each mode of transportation	Traffic counts and/or modeling.
Recreational Value	Change in cycle kilometers and cyclists' statements.	Interviews and traffic counts and/or modeling.
Health Benefits	Change in cycle kilometers.	Traffic counts and/or modeling.
Safety	Change in the number of accidents, cyclist statements and change in cycle kilometers.	Accident registrations, interviews and traffic counts and/or modeling
Discomfort	Change in cycle kilometers.	Traffic counts and/or modeling.
System Benefits	Change in cycle kilometers.	Traffic counts and/or modeling.

Fig. 13 Methodology to quantify traffic effects. Source, Economic evaluation of cycle projects – methodology and unit prices, 2009, COWI, City of Copenhagen

Behind this tool lies a rich database with key figures on time values, health effects, environmental effects, accidents and so on. When all these figures are translated into a per kilometer value, it is possible compare the costs and benefits of the bicycle to those of driving a car or travelling by public transport. According to this study riding a bicycle is €0,41 more beneficial to society than driving a car per kilometer. So every kilometer on a bike instead of a car has 0,41€ of benefits to society. The effect of lower congestion due to less car kilometers is the largest part of this. Health effects (life years) are relatively low in this case but it's important to notice that these values are applicable to the Dutch case where physical activity is already relatively high. The societal benefits of riding a bike instead of travelling by bus are even larger; every kilometer on a bike instead of in a bus brings €0,51 of societal benefits.

There are other tolls available on the web as The Health Economic Assessment Tool. The HEAT for cycling is a tool online designed by the World Health Organization. This tool provides quantitative information regarding the health benefits of active transportation (cycling and walking) establishing a methodology for an economic assessment of the health effects. According to this methodology, it results that ride a bike regularly (30 minutes a day) reduces of the 15% the risk of mortality.

This paper wants to show the triple sustainability of cycling: economical, environmental and social. From the CBA proposed it' s evident that investing in cycling, rather than in other way of transport, is fundamental for the sustainable development of towns (less pollution, noise, ...), to ameliorate the quality of life and it's less expensive than investing in cars or public transport. Benefits overpass Costs.

It is important to conclude reporting some recommendations for a good cycling policy:

- cycling policy needs continuous political leadership and coordination from the very top down;
- as the main socio-economic benefit of cycling is on the health side. Health departments should actively reach out to other departments for fully inclusive cycling policies. This also relates to the concept of health in all policies;
- the polluter pays principle is finding more and more political support. The European Commission stated in the White Paper on Transport (2011) the ambition to proceed to the full and mandatory internalization of external costs (including noise, local pollution and congestion);
- to use European funding to create a mixed partnership (public and private) to promote projects in cycling;
- to do Sustainable Mobility Plan that includes a CBA. This report shows that almost every CBA on cycling investment turns out to be very positive; the social costs outweigh the benefits by far;
- to consider cycling as an integral part of the total Mobility Plan of a city. Synergies with public transport are an important part of that;
- to work for a new green economy including bicycles considering that: cycling spend more than car drivers; cycling employees are more productive and deliver better quality; the cycle economy ensures economic and social gains.

REFERENCES

Akinder, M. (2010). Policy Manual for Calculating Greenhouse Gas Benefits of Global Environment Facility Transportation Projects. New York: UNEP.

Banister, D. (2008). The sustainability mobility paradigm. (15) 73–80. Elsevier: USA.

Beukers, E., L. Bertolini & M. Te Brömmelstroet (2012). Why Cost Benefit Analysis is perceived as a problematic tool for assessment of transport plans: A process perspective. Transportation Research Part A, 68–78. USA: Elsevier.

Cecchini, A., & Talu, V. (2011). Camminare (e pedalare) per trasformare la città. *TeMA Journal of Land Use, Mobility and Environment* (4), Mobilità e Conflitti, 4/11, 99-108, ISSN 1970-9870. Napoli: Università degli Studi di Napoli Federico II. http://www.tema.unina.it

Cramer, M. (2009), Soft mobility Measures for a climate-friendly transport policy in Europe, Brussels: The Greens.

Department of Industrial Engineering, Mechanical Faculty, Yildiz Technical University (2009), Evaluating the environmental effects of transportation modes using an integrated methodology and an application. Vol.6, 277-290. Iran: International Journal of Environmental Science & Technology.

Dougherty, M. (1995). A review of neural networks applied to transport. Vol.3, 247–260. USA: Elsevier.

Ege, C. & Krag, T. (2002). Cycling will improve environment and health. Vol.37, 766-777. USA: Elsevier.

European Commission (2009). A sustainable future for transport: towards an integrated, technology-led and user friendly system. Luxemburg: Publications Office of the European Union.

European Parliament (2012). The European Cycle Route Network Eurovelo, Challenges and Opportunities for Sustainable Tourism. Brussels: Publications Office of the European Union.

EU transport (2014). European statistical pocketbook. Belgium: Publications Office of the European Union.

Haezendonck, E. (2007). Transport Project Evaluation: Extending the Social Cost-Benefit Approach. Amsterdam: VU University Amsterdam.

Institute for sensible transport (2012). Integrating cycling with public transports. Australia: Queensland.

La Rocca, R. A. (2010). Soft Mobility and Urban Transformation. *TeMA Journal of Land Use, Mobility and Environment*, Selected Paper, (SP.09) 3/10. doi: 10.6092/1970-9870/2f493. ISSN 1970-9870. Napoli: Università degli Studi di Napoli Federico II.

London Borough of Merton (2014), Analysis of private investment infrastructure. UK: Project CycleCities.

Mackie, P. (2010). Cost-Benefit Analysis in Transport: A UK Perspective. Mexico: Publications Office of the International Transport Department.

May, A.D., Page, M., & Hull, A. (2008). Developing a set of decision-support tools for sustainable urban transport in the UK. Vol 9, 184-201. UK: EJTIR.

Mouter, M., Annema, J., & van Wee, B. (2013). Cost-Benefit Analysis in Practice. Belgium: Nicis Institute.

Municipality of Genoa & DICCA-University of Genoa (2014). Analysis of environmental aspects, enrichment of individual reports, development of synthesis report. Italy: Project CycleCities.

Odgaard, T., K, C., Laird, J. (2005), Current Practice in Project Appraisal in Europe, Trafikdage Aalborg Universitet, DK: Institute for Transport Studies.

Regional Development Agency of Gorenjska - BSC, Kranj (2014). Analysis of public investment costs, inhibitors and externalities. Slovenia: Project CycleCities.

Rotaris, L., Danielis, R., Marcucci, E., &Massiani, J. (2010). The urban road pricing scheme to curb pollution in Milan, Italy: Description, impacts and preliminary cost-benefit analysis assessment. Transportation Research, (Part A) 359–375., USA: Elsevier.

Saelens, B.E. et al (2003). Environmental Correlates of Walking and Cycling: Findings From the Transportation, Urban Design, and Planning Literatures. Annals of behavioral medicine. DK: Publications Office of the Danish Ecological Council.

Tight, M. (2011), Visions for a walking and cycling focussed urban transport system. Institute for Transport Studies. UK: University of Leeds.

Vickerman, R. (2000). Evaluation methodologies for transport projects in the United Kingdom. Transport Policy Vol.7, 7-16, USA: Elsevier. doi:10.1016/S0967-070X(00)00009-3

Whitelegg, J. (2008). Integrating Sustainability into the transport. Stockholm Environment Institute. UK: University of York.

Zadeh, L. A. (1975). Fuzzy logic and approximate reasoning. India: India Statistical Institute.

IMAGE SOURCES

Cover: Cycling in Amsterdam, Jorge Royan Phot
Fig. 1, fig. 3, fig. 4, fig. 10, fig. 11, fig. 12: elaborated by the authors
Fig. 2: Björn Lexius and Till Gläser image
Fig. 5: Regional Development Agency of Gorenjska BSC, Siebe Visser, Kees van Ommeren – Decisio, Pascal van den Noort – Velo Mondial, Slovenia, 2014
Fig. 6: National Transport Authority of Ireland, 2014
Fig. 7: National Transport Authority of Ireland, 2014
Fig. 8: Bike Parking for Your Business, City of Ann Arbor, 2008
Fig. 9: Mariordo (Mario Roberto Duran Ortiz) Photo
Fig. 13: City of Copenhagen, 2009

AUTHORS’ PROFILES

Francesca Pirlone

PhD, engineer and assistant professor in town planning at Polytechnic School - University of Genoa. She has developed different lines of research, from requalification, natural risks, sustainability, infrastructures and mobility, activities carried out in particular in EU programs. Author of numerous publications and speakers at International and National Conferences.

Selena Candia

She is graduated in architecture and construction engineer. Actually she is working for the Municipality of Genoa – Culture and Tourism department - European Project Office as European project manager. She managed different European projects about sustainable development and urban regeneration.

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 1 (2015) 103-126
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2928

How to cite item in APA format:
Angiello, G., Carpentieri G., Niglio, R., Russo L., Tulisi A. (2015). Review Pages. Cities, energy and climate change. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 103-126. doi: http://dx.doi.org/10.6092/1970-9870/2928

REVIEW PAGES

CITIES, ENERGY AND CLIMATE CHANGE

Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. During the last two years a particular attention has been paid on the Smart Cities theme and on the different meanings that come with it. The last section of the journal is formed by the Review Pages. They have different aims: to inform on the problems, trends and evolutionary processes; to investigate on the paths by highlighting the advanced relationships among apparently distant disciplinary fields; to explore the interaction's areas, experiences and potential applications; to underline interactions, disciplinary developments but also, if present, defeats and setbacks. Inside the journal the Review Pages have the task of stimulating as much as possible the circulation of ideas and the discovery of new points of view. For this reason the section is founded on a series of basic's references, required for the identification of new and more advanced interactions. These references are the research, the planning acts, the actions and the applications, analysed and investigated both for their ability to give a systematic response to questions concerning the urban and territorial planning, and for their attention to aspects such as the environmental sustainability and the innovation in the practices. For this purpose the Review Pages are formed by five sections (Web Resources; Books; Laws; Urban Practices; News and Events), each of which examines a specific aspect of the broader information storage of interest for TeMA.

01_WEB RESOURCES
The web report offers the readers web pages which are directly connected with the issue theme.

author: Raffaella Niglio
TeMALab - Università Federico II di Napoli, Italy
e-mail: raffaella.niglio@unina.it

02_BOOKS
The books review suggests brand new publications related with the theme of the journal number.

author: Gerardo Carpentieri
TeMALab - Università Federico II di Napoli, Italy
e-mail: gerardo.carpentieri@unina.it

03_LAWS
The law section proposes a critical synthesis of the normative aspect of the issue theme.

author: Laura Russo
TeMALab - Università Federico II di Napoli, Italy
e-mail: laura.russo@unina.it

04_URBAN PRACTICES
Urban practices describes the most innovative application in practice of the journal theme.

author: Gennaro Angiello
TeMALab - Università Federico II di Napoli, Italy
e-mail: gennaro.angiello@unina.it

05_NEWS & EVENTS
News and events section keeps the readers up-to-date on congresses, events and exhibition related to the journal theme.

author: Andrea Tulisi
TeMALab - Università Federico II di Napoli, Italy
e-mail: andrea.tulisi@unina.it

TeMA 有关土地使用、交通和环境的杂志

TeMA 1 (2015) 103-126
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2928

How to cite item in APA format:
Angiello, G., Carpentieri G., Niglio, R., Russo L., Tulisi A. (2015). Review Pages. Cities, energy and climate change. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 103-126. doi: http://dx.doi.org/10.6092/1970-9870/2928

评述页

城市、能源与气候变化

TeMA从城市规划和流动性管理之间的关系入手，将涉及的论题逐步展开，并始终保持科学严谨的态度进行深入分析。在过去两年中，智能城市课题和随之而来的不同含义一直受到特别关注。学报的最后部分是评述页 这些评述页具有不同的目的：表明问题、趋势和演进过程；通过突出貌似不相关的学科领域之间的深度关系对途径进行调查；探索交互作用的领域、经验和潜在应用；强调交互作用、学科发展、同时还包括失败和挫折（如果存在的话）。评述页在学报中的任务是，尽可能地促进观点的不断传播并激发新视角。因此，该部分主要是一些基本参考文献，这些是鉴别新的和更加深入的交互作用所必需的。这些参考文献包括研究、规划法规、行动和应用，它们均已经过分析和探讨，能够对与城市和国土规划有关的问题作出有系统的响应，同时还对诸如环境可持续性和在实践中创新等方面有所注重。因此，评述页由五个部分组成（网络资源、书籍、法律、城市实务、新闻和事件），每个部分负责核查TeMA所关心的海量信息存储的一个具体方面。

01_WEB RESOURCES
The web report offers the readers web pages which are directly connected with the issue theme.

author: Raffaella Niglio
TeMALab - Università Federico II di Napoli, Italy
e-mail: raffaella.niglio@unina.it

02_BOOKS
The books review suggests brand new publications related with the theme of the journal number.

author: Gerardo Carpentieri
TeMALab - Università Federico II di Napoli, Italy
e-mail: gerardo.carpentieri@unina.it

03_LAWS
The law section proposes a critical synthesis of the normative aspect of the issue theme.

author: Laura Russo
TeMALab - Università Federico II di Napoli, Italy
e-mail: laura.russo@unina.it

04_URBAN PRACTICES
Urban practices describes the most innovative application in practice of the journal theme.

author: Gennaro Angiello
TeMALab - Università Federico II di Napoli, Italy
e-mail: gennaro.angiello@unina.it

05_NEWS & EVENTS
News and events section keeps the readers up-to-date on congresses, events and exhibition related to the journal theme.

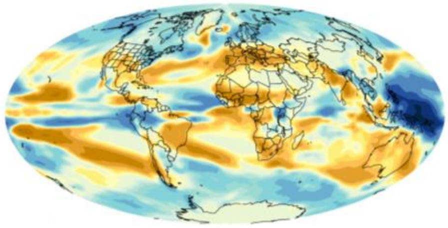
author: Andrea Tulisi
TeMALab - Università Federico II di Napoli, Italy
e-mail: andrea.tulisi@unina.it

01

CITIES, ENERGY AND CLIMATE CHANGE

REVIEW PAGES: WEB RESOURCES

RAFFAELLA NIGLIO
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: raffaella.niglio@unina.it



In this number

PLANNING FOR SUSTAINABILITY AND CLIMATE CHANGE

Over 50% of the world population lives in cities. More than two thirds of the world's largest cities are vulnerable to rising sea levels as a result of climate change. Millions of people are being exposed to the risk of extreme floods, storms, temperatures and winds. Moving to the causes of the mentioned phenomena, the GHG emissions are widely recognized as the main contributors to climate change: carbon dioxide (CO_2) is the most important anthropogenic GHG and recent data confirm that consumption of fossil fuels accounts for the majority of global anthropogenic GHG emissions. Researchers and policy makers are devoting their attention to outline strategies for urban adaptation to climate change, both at European and local scale.
Two are the main typologies of strategies that at global, European and local level are currently put in place:

- mitigation measures, aimed at reducing GHG emissions;
- adaptation measures, aimed at adjusting natural or human systems in response to actual or expected climatic stimuli or their effects.

The two types of strategies also differ one from each other, both from a temporal and a spatial perspective. Mitigation measures are generally the result of international strategies, although applied at national or local levels, and are referred to a long-term perspective. Adaptation measures are strongly characterized as site-specific measures; they generally refer to the scale of the impacted system and are undertaken at local level, although based in some cases on a wider common platform at national or upper level (Galderisi, Ferrara 2012).
In this number three websites are presented; they are related to three theoretical and methodological approaches to urban adaptation to climate change, depending on the context. The first one addresses the significant extents of the city of Rotterdam, which is an international seaport city with a strong industry sector based on fossil fuels and raw materials but has great ambitions to realize 50% reduction of CO_2 emissions and to become 100% climate proof in order to maintain its international top position and to benefit optimally from the economic opportunities that are created in this context. The second website describes the Italian experience of BLUE UP project whose aim is to provide Bologna with a Local Adaptation Plan, to make the town more resilient in the face of climate change. In the end, the SymbioCity website offers the Sweden conceptual framework for support to climate change challenges in low and middle income countries.

ROTTERDAM CLIMATE INITIATIVE
http://www.rotterdamclimateinitiative.nl/

The Rotterdam approach to climate change is unique in the world. The Rotterdam Climate Initiative (RCI) is a partnership between the Port of Rotterdam, the companies of the industrial port district, the municipality and the environmental protection agency Rijnmond, with the goal of reducing CO_2 emissions by 50% by 2025, as compared to the level in 1990, and to address the issue of climate change through mitigation and adaptation policies in combination with economic growth in the Rotterdam Region. It was launched in November 2006 by an advisory body of the Mayor and Aldermen of Rotterdam as part of the international Clinton Climate Initiative. One year after the collective initiators joined their forces to participate in an international climate programme for metropoles. Since the end of 2013, Rotterdam has had its own adaptation strategy which has set out the course that the city wishes to take to prepare for climate change. The focus of attention in the RCI is on energy conservation, sustainable energy and capture, reuse and storage of CO_2. Through knowledge development, innovation and sustainable area development, Rotterdam furthermore responds to the challenge of changing water levels as a result of climate change. Moreover, the international network of stakeholders helps new companies motivated in reducing CO_2 emissions and adapting to climate change to set up their business in a global market.

RCI website is a rich source of information for those who are interested in the comprehensive climate file. It is organized into seven sections: Publications, Press releases, Contact, About us, Projects, Clips and News.

The section *Publications* lists all of the publications in English published by the RCI from 2008 to 2014. In this section users have free access to interesting reports, programmes, brochures and flyers which provide answers to questions about the effects of global climate change for Rotterdam or about how can inhabitants of Rotterdam contribute to keep their city safe and habitable, now and in the future. Furthermore in compliance with the idea to support the free global exchange of knowledge all the publications can be easily accessed on line and downloaded.

Press release section contains all of the press releases published by the RCI as well as the press releases of the RCI adaptation programme, Rotterdam Climate Proof (RCP). In the section *About us* users can find short information about the RCI board and its relations with the Rotterdam municipality departments, the government bodies and the NGOs and knowledge institutes. Also some information on the mission and the ambition of the network are given.

The section *Project* is mostly dedicated to an in-depth analysis of the new or currently underway works which help Rotterdam urban region to achieve his climate proof objectives. They are new or renovated adaptive urban spaces which benefit the city environment such as a tidal park; a full-scale water square; floating constructions; green roofs; multi-functional rowing courses; waterway corridors; underground water storages; playgrounds doubling as water storage; dynamic traffic management practices; green façades. In this section users can find also guidelines, researches, reports, videos, apps and games to adapt to climate changes by achieving maximum benefit for residents and businesses. The topics are not only energy saving, sustainable energy, electric mobility but also the capture, reuse, transport and underground storage of carbon dioxide (CSS). The section *Clips* offers a large variety of video products and interviews for sharing knowledge about methods used by cities to manage climate risks such as extreme rainfall, flood risks and high temperatures. Watching these videos users can learn from extreme incidents or can gather information about adaptation measures and instruments for decision making. In the end, the section *News* collects the latest announces about current events, ongoing projects and the new steps forward in the field of mitigation and adaptation to climate change.

BLUEAP | BOLOGNA ADAPTATION PLAN FOR A RESILIENT CITY

https:// http://www.blueap.eu/

BLUE AP (Bologna Local Urban Environment Adaptation Plan for a Resilient City) is a LIFE + Project (LIFE11 ENV/IT/119) for the implementation of the Plan of Adaptation to Climate Change for the city of Bologna.

The project kicked off on October 1, 2012 and is going to end on September 30, 2015.

The Municipality of Bologna is the coordinator of the project which involves three other partners: a non-profit organization, Kyoto Club; Ambiente Italia that is an expert European center for urban and environmental policies; ARPA Emilia Romagna which is the Regional Government's Agency for Environmental Protection and Prevention.

The project is aimed to provide some concrete measures which can be implemented at the local level in order to make the city less vulnerable and able to positively react in case of floods, droughts and other consequences of climate change.

Bologna will be a pilot-city addressing in Italy the challenge of climate change which is nowadays considered a priority at European and national level.

The creation of a Local Climate Profile and the involvement of relevant stakeholders as well of citizens have been paramount for the development of the projects. Once BLUEAP is completed, within the site users will find guidelines useful for the redaction of similar Adaptation Plans as a model framework which could be adopted by other medium size Italian cities.

The goal of the website is to create specific information on adaptation issue, which has been attracting a growing interest in recent years. In order to encourage the widest possible dissemination of the project contents and materials, the BLUE AP website is simple and user-friendly.

It consists of six sections: *News, About, Project, Scientific board, Documents, Calendar, Forum* and *Contact*.

The *News* section provides to users the most interesting informative articles published in media dealing not only with climate change, adaptation and resilience but also with water management, drought, heat islands, and greening initiatives; only a small summary is published and original sources or individual authors are indicated at the bottom of each article.

Moreover, in this section also technical articles and press releases reporting the activities carried out by the BLUEAP Scientific Board are collected.

In the section *About* the most relevant information on the project partners are given. They include also contacts. The section *Projects* contains the description of the six pilot actions planned by the BLUEAP project and aimed to build resilient communities and to raise awareness about the risks associated with climate change. In the section *Documents* users can access and download the results and the products created within the project: informative brochure; dissemination and communication plan; Local Climate Profile analysis; best practices in the field of adaptation to climate change; local strategies; adaptation plan; questionnaire for visitors to the site and surveys.

In order to effectively reach on time bodies and organizations concerned with the project goals and topics of the project, direct communication with the identified target audience is crucial. For this reason, BLUEAP is also present on the new communication channels such as Facebook, Twitter and Linkedin.

Furthermore, at the bottom of every section of the website users have the opportunity to subscribe for the newsletter.

SYMBIOCITY | SUSTAINABILITY BY SWEDEN

www.symbiocity.org

SymbioCity is a Swedish government initiative on the issue of sustainable urban development. Founded in 2008, the primary goal of the program is to export the knowledge of Sweden experience on sustainable cities. The Swedish Association of Local Authorities and Regions (SALAR) and its subsidiary SKL International has been commissioned by Sida to foster and develop the Symbio City Approach between 2010 and 2013. According to the holistic and integrated approach of SymbioCity, environmental and economic gains result from unlocking synergies between urban systems, integrating different technologies and functions of the city. For example, waste can be transformed into energy, waste water can turn into fuel, and excessive heat from an industrial area can warm up a household. A sectoral approach should be replaced by a multi-disciplinary approach in order to succeed in solving combined problems. The conceptual framework collects the Swedish methodology and experiences, with a focus on the practices of local government. It is scalable framework and it can be adaptable to any climate.

In the homepage of Symbiocity website users can find a slideshow gallery that combines short texts with images in order to communicate the concept of the initiative. On the right of the slideshow gallery there are fast links to the main sections of the website. Moreover, there are small overviews, organized into a grid, aimed at promoting the approach and at showing some successful cases of industrial districts transformed into sustainable urban environments, e.g. the case of Western Harbour in Malmo or the district of Gårdsten in Gothenburg. At the end of the homepage the latest news about SymbioCity are presented.

The website is organized into four main sections each of them have a bar menu. The section *DISCOVER* collects information about the methodology which can be applied from single blocks to entire urban areas. The seven building blocks in which SymbioCity works are: Architecture; Energy; Landscape Planning; Traffic & Transport; Waste Management; Urban Functions, Industry and Buildings; Water Supply and Sanitation. In this section some experiences and cases are listed. The *DEVELOP* section shows the six steps to achieve the holistic partnerships that will drive to transition to sustainability. Furthermore, this section offers a toolbox to help users to reach sustainable development. In the toolbox users can find useful instruments, for example organizational diagrams for planning and review work; SWOT analysis for identifying and weighing up the negative and positive qualities of an urban territory; some set of indicators for tracking progress in planning and development. At the bottom of this section there is the opportunity to launch a game in which sustainable scenarios, depending on differing conditions and cultures, are shown. Information about tailor made visiting programs, access days or specific training programs can be found in *GET GOING* section. Finally the *NETWORK* section shows a list of companies affiliated to Symbiocity which can be filtered by business area and geographic position. The list of companies is kept continuously up to date. At the bottom of the section users can find also contacts and address of the organization.

REFERENCES

Galderisi, A., & Ferrara, F. (2012). Enhancing urban resilience in face of climate change: a methodological approach. *Tema. Journal Of Land Use, Mobility And Environment*, 5(2), 69-88. doi:http://dx.doi.org/10.6092/1970-9870/936

IMAGE SOURCES

The images are from: www.climatemonitor.it; www.rotterdamclimateinitiative.nl; www.blueap.eu; www.symbiocity.org.

02

CITIES, ENERGY AND CLIMATE CHANGE

REVIEW PAGES: BOOKS

GERARDO CARPENTIERI
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: gerardo.carpentieri@unina.it

In this number

ENERGY CONSUMPTION AND CLIMATE CHANGE IN URBAN AREAS

Cities are undergoing a renaissance, with a huge growth in urban population. In 1900, about 13 per cent of the global population was urban, but by 2000 this proportion was 47 per cent, and the 50 per cent threshold was reached in 2007 when 3.3 billion people lived in urban areas. By 2050, nearly 70 per cent (6 billion) of the global population (9 billion) will be living in urban areas. This enormous urban growth are causing congestion, traffic, polluting air, noise and energy consumption, also due to the high density of urban activities. The combination of environmental effects clearly measurable and the energy price crisis produced by the explosion of global demand, reveals strongly the urgency to afford the problem in a multi-sectorial and systemic perspective (Gargiulo et al., 2012).

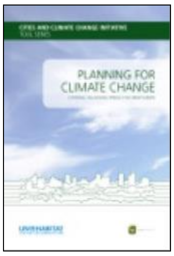
Besides population, in the cities are concentrate disproportionate parts of the economy, resource consumption and the decision making power in most countries. Nearly 75 per cent of the global economic production takes place in urban areas. Cities are responsible for 67 per cent of the total global energy consumption and more than 70 per cent of greenhouse gas emissions and these trends significantly intensify the severity of some of the two great challenges of our time: climate change and energy security (UN Habitat, 2011).

It is not cities, or urbanization per se , that contribute to greenhouse gas emissions, but rather the way in which people move around the city, sprawling urban development, the amount of energy people use at home and to heat buildings that make cities the great consumers of energy and polluters that they are.

In particular, urban density and spatial organization are crucial elements that influence energy consumption, especially in transportation and building systems (World Bank, 2010).

So changes to the built environment both to adapt to climate change and to limit emissions require long lead times, which heightens the urgency of implementing land-use zoning, spatial, building and transportation policies now (OECD, 2010).

According to these brief considerations, this section proposes three documents that help to better understand the issue of this number: the first document Planning for climate change is a guide for city planners and other professionals to help the urban communities in low and middle-income countries; in the second document City Resilience Framework is collected and analyzed a set of indicators that useful to describe the fundamental attributes of a resilient city; in the third document Transport, Climate Change and the City seeks to develop achievable and low transport CO_2 emission futures in a range of international case studies.



Title: Planning for climate change
Author/editor: John Ingram and Colleen Hamilton
Publisher: UN-Habitat
Download: http://www.unhabitat.org
Publication year: 2014
ISBN code: 978-92-1-132400-6

This guide published by the UN agency UN-HABITAT for a Better Urban Future. It describes a strategic values-based approach for urban planners was developed for city planners and other professionals to better understand, assess and take action on climate change at the local level. While climate change is a global issue, this guide is specifically intended for urban communities in low and middle-income countries where the challenges are unique and the stakes of planning for climate change are particularly high. The primary audience for this guide is city planners working in cities in low and middle-income countries who have a basic knowledge of climate change and the desire to address it.

An another group that can use this guide are the elected representatives, non-government professionals, civil society groups, donor agencies and private sector organizations who individually and collectively affect how cities manage climate change risks, impacts and vulnerabilities.

To help the diversity of users, their differing capacities, available resources, experience, and the range of political contexts that they will find themselves in, this guide presents a broad range of tools and information.

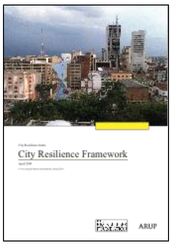
This guide's planning process is organized around a four-module strategic planning approach that incorporates innovative decision-making tools with a participatory, community-based methodology. It can be used to support city climate change planning processes and as a stand-alone capacity building resource and training tool. To help integrate climate change planning into current planning and urban development initiatives, and make it easier for urban planners to take action on climate change, this guide is organized around a four step strategic planning approach that incorporates innovative decision-making tools with a participatory, local values-based methodology.

Each module asks a specific planning question and requires guide users to go through a corresponding set of individual steps, which are supported by 42 different planning tools. The planning tools are provided in a companion document, Planning for Climate Change: A strategic values-based approach for urban planners toolkit.

This guide takes the approach that climate change planning can, and should, augment and be integrated and mainstreamed with existing city plans, planning processes and development activities across all sectors. climate change is simply another piece of information that should be considered during every planning process, or when existing plans are modified and updated.

fundamentally, good city planning practices are, by their nature, also climate smart planning practices. This is because most climate change planning actions are consistent with planners' responsibilities, including:

- Minimizing risk and improving land development activities that occur in or near flood, slope or coastal hazard areas;
- Improving infrastructure for storm water management, solid and liquid waste management, access to safe drinking water, and the movement of goods and people;
- Protecting ecosystems and environmentally sensitive areas in and around towns and cities;
- Improving disaster risk reduction, including the improvement of response capacities for disasters (particularly weather and climate-related events);
- Supporting local economic development to reduce poverty and improve quality of life.



Title: City Resilience Framework
Author/editor: Jo da Silva, Braulio Morera
Publisher: The Rockefeller Foundation and ARUP
Download: http://publications.arup.com/Publications/C/City_Resilience_Framework.aspx
Publication year: 2014
ISBN code: n.d.

The City Resilience Framework provides a lens through which the complexity of cities and the numerous factors that contribute to a city's resilience can be understood.

In addition, cities need to ensure that their development strategies and investment decisions enhance, rather than undermine, the city's resilience. This analysis comprises a set of twelve key indicators that describe the fundamental attributes of a resilient city.

A resilient city is a city where there is or are: Minimal human vulnerability; Diverse livelihoods and employment facilitated; Adequate safeguards to human life and health; Collective identity and mutual support; Social stability and security; Availability of financial resources and contingency funds; Reduced physical exposure and vulnerability; Continuity of critical services; Reliable communications and mobility; Effective leadership and management; Empowered stakeholders; Integrated development planning. The twelve indicators fall into four categories:

- the health and wellbeing of individuals (people);
- infrastructure and environment (place);
- economy and society (organization);
- leadership and strategy (knowledge).

They represent the fundamental elements of a resilient city. They are what enable people to survive and thrive and businesses to prosper despite adverse circumstances.

For each category, it is reported a best case which represents a resilient city, and a worst case which equates to breakdown or collapse.

The indicators are complemented by qualities that distinguish a resilient city from one that is simply livable, sustainable or prosperous.

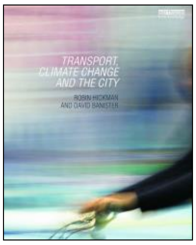
This guide incorporates a strategic planning approach with the belief that all planning is more effective if it's strategic. This is because no matter the type of planning, all of it is ultimately about making the best long-term decision possible. To plan for climate change adaptation using a more strategic approach will not only help communities decide what to do, but also how to do it and when to do it, making decision-making more transparent and objective.

This climate change planning process is not linear. Although it follows a step-by-step process, it is designed to let cities revisit steps as new information becomes available, new stakeholders become involved, or other circumstances change.

This guide is designed to allow users to enter the strategic planning process at different steps or modules. It is anticipated that guide users and their cities will:

- Be at different stages of climate change planning;
- Be using the guide for different purposes;
- Have different planning structures and processes;
- Have different resources and capacities.

Primary audience for City Resilience Framework is municipal governments. But, the framework, indicators and variables are also intended to support dialogue between other stakeholders who contribute to building more resilient cities globally.



Title: Transport, Climate Change and the City
Author/editor: Robin Hickman and David Banister
Publisher: Routledge
Download: n.d.
Publication year: 2014
ISBN code: 978-0-415-66002-0

Cities have become the centers of humanity and in the last 10 years, in particular, much discussion has focused on sustainability, reducing greenhouse gas (GHG) and carbon dioxide (CO_2) emissions. Within this, there are aspirations towards sustainable travel. This book takes this difficult context as its starting point, developing its approach from an exciting body of work in scenario analysis and futures thinking. It draws on the conceptual origins from Thomas More's (1516) Utopia, and others such as Herman Kahn and Pierre Wack. Futures analysis has developed into a wide literature field: scenarios have been well used in many domains, notably in business and corporate strategy, and also in energy futures and, to an extent, in transport and city planning. The authors view scenarios from the tradition of Herman Kahn, encompassing a wide range of external and internal factors, such as changed environmental, economic and cultural factors, into composite images of different potential future lifestyles forming a structured view of the future and framework for analysis. This is different to much of the common parlance in transport planning, where scenarios are conflated with option analysis, considering marginal changes, such as route alignments or changes in frequency of service. They use scenario analysis to explore much more fundamental possibilities for changed travel behaviors.

The authors propose the analysis the climate change transport problems and the differents solutions in five different urban areas of the world:

- Ambitions towards sustainable mobility (City of London);
- Affluent rurality and car dependence (City of Oxford);
- Breaking the projected (City of Delhi);
- Building a new world (City of Jinan);
- Urban dispersal and high motorisation (City of Auckland).

REFERENCES

Gargiulo, C., Pinto, V., & Zucaro, F. (2012). City and mobility: towards an integrated approach to resolve energy problems. *Tema. Journal Of Land Use, Mobility And Environment, 5*(2), 23-54. doi:http://dx.doi.org/10.6092/1970-9870/920

Hickman, R., & Banister, D. (2014). *Transport, climate change and the city*. Routledge.

OECD. (2010). Cities and Climate Change.

World Bank. (2010). Cities and climate change: an urgent agenda.

03

CITIES, ENERGY AND CLIMATE CHANGE

REVIEW PAGES: LAWS

LAURA RUSSO
TeMALab - Università degli Studi di Napoli Federico II, Italy
e-mail: laura.russo@unina.it

In this issue

EUROPEAN AND ITALIAN STRATEGY ON ENERGY AND CLIMATE CHANGE

The gradual increase of the average global temperature, which today is 0.8°C higher than that registered in the pre-industrial period, is only one of the many effects of climate change; in Europe, the temperature has been rising faster, as shown by data that indicates a difference of 1.3°C with the pre-industrial levels (EEA 2012). Furthermore, together with global warming, other alarming consequences of climate change, related to the greater frequency of extreme weather events such as heat waves or heavier rainfall, are challenging the EU territory which therefore must focus its attention on this issue, considering it a priority for the sustainable development of our society.

In line with the goal of facing the impacts of climate change, the European Union has been promoting mitigation and adaptation efforts based on a policy framework for climate and energy with ambitious and pioneering efficiency targets. Indeed, as long as global warming represents a dangerous risk for our planet, it is crucial to impose a number of actions aimed at reducing greenhouse gas emissions, as well as at increasing the shares of renewable energy, in order to encourage the transition towards a more sustainable energy system and to limit further changes in the earth's climate.

Both at national and international level, the efforts to promote a more sustainable development have been increasing in the last decade and, not surprisingly, Europe is at present a global leader in addressing this challenge. However, the largest emitters of carbon dioxide are China (29%) and the United States (16%), while Europe is just in third position, with the 11% of global emissions. Although the concern for air pollution and energy security has pushed China to invest in renewable energy, its CO_2 emissions do not seem to slow down, on the contrary, in 2012 US emissions have decreased by 4% (EEA 2012).

In 2008 the European Commission has adopted its first policy for climate and energy (EU 30/2008), defining two key targets: a reduction of at least 20% in greenhouse gases by 2020 and a 20% share of renewable energies in EU energy consumption by 2020. These ambitious measures have been updated with the approval of a new policy framework, at the beginning of 2014 (EC 15/2014), which includes new key achievements to be attained by 2030. This document will be described in this number of the journal, together with the EU strategy on adaptation to climate change (EC 216/2013), which sets out a number of measures to improve the resilience of the EU territory. In conclusion, the Italian strategy on adaptation to climate change (MATTM 2014) will be investigated in order to identify the group of actions the Italian government intends to implement to face the impact of climate change at national, regional and local scale.

COM(2014) 15 – A POLICY FRAMEWORK FOR CLIMATE AND ENERGY IN THE PERIOD FROM 2020 TO 2030

Many steps forward have been made since the EU has established the 20/20/20 targets in 2008. However, now the time has come for the European Union to evaluate what has been done and, even more important, what needs to be done by 2030 in order "to drive progress towards a low-carbon economy which ensures competitive and affordable energy for all consumers, creates new opportunities for growth and jobs and provides greater security of energy supplies and reduced import dependence for the Union as a whole" (EC 15/2014). With these goals, in 2014, the EU has adopted a new policy framework for climate and energy, defining two new energy targets for 2030:

- a reduction of greenhouse gas emission (GHG) of 40% in 2030 compared to 1990;
- a share of renewable energy of at least 27% by 2030.

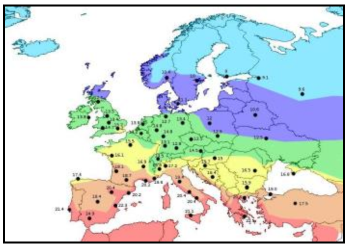
In addition to these two targets, the policy framework identifies a number of different aspects to be considered. For example, improving energy efficiency represents a crucial element for mitigating the impacts of climate change; even tough the objective of 20% by 2020 seems still far at the moment, the Commission has calculated that the GHG emissions reduction target of 40% would require an increased level of energy savings of approximately 25% in 2030.

Furthermore, the EU considers high levels of competition in the internal energy market a further priority for the achievement of energy policy goals: "it will provide the key tools to contain energy prices for business and households. A fully integrated and competitive energy market could result in cost savings of between €40-70 billion up to 2030 as compared to today" (EC 15/2014). The achievements just described are promoting by the EU so as to preserve the flexibility for Member States to set national goals that, however, must be consistent with the European governance framework; in fact, in order to guarantee the respect of energy targets established at European level, Member States should adopt national plans that include precise domestic objectives for "the delivery of a competitive, secure and sustainable energy system" (EC 15/2014). A three steps process will support the drawing up of such plans, which should be implemented well before 2020:

- The Commission will define the content of national plans in detail;
- Member States will draw up the plans based on the Commission guidance and on the consultation with neighboring countries;
- The Commission will evaluate the plans in order to verify if the national goals are adequate for the achievement of the Union's energy targets.

Nevertheless, the EU considers these plans necessary but not sufficient to ensure that the policy framework for climate and energy is fulfilled; for this reason, the Commission will monitor progress over time by measuring a number of key indicators, that should asses the respect of the energy objectives with a more accurate and scientific approach.

In conclusion, the new 2030 climate and energy policy framework, in line with the 20/20/20 targets, promotes the reduction of GHG emissions, the increase of the share of renewable energy, higher competition in the Member States' energy market and the definition of an European governance process based on national plans with the common goal of encourage the sustainable development of our planet and mitigate the impacts of climate change.



COM(2013) 216 – AN EUROPEAN STRATEGY ON ADAPTATION TO CLIMATE CHANGE

Climate change has become a matter of global concern since its impacts have negatively affected territories from an environmental, social and economic perspective. The rise in the number of extreme weather events – e.g. heat waves, heavier precipitation and flooding – is likely to increase the magnitude of disasters, leading to significant economic losses, public health problems and deaths (EC 216/2013). In Europe, despite some territories are more vulnerable than others, just think to the coastal areas or the Artic regions, no country can consider itself safe from the risks related to climate change. For this reason it is necessary to implement adaptation measures to limit the consequences of global warming regardless of the positive results that might be achieved by mitigation actions.

In line with this awareness, the EU has approved the strategy on adaptation whose goal is "to contribute to a more climate-resilient Europe. This means enhancing the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination" (EC 216/2013).

Eight actions can be envisaged to implement the strategy:

- The Commission will provide instructions to foster all Member States to adopt adaptation strategies;
- The Commission will financially support adaptation activities through the LIFE funding (2013-2020);
- Adaptation in cities will be introduced in the Covenant of Mayors framework;
- The knowledge gap will be refined in order to better investigate different aspects related to adaptation actions, such as their real costs and benefits, or the most appropriate methodology for monitoring and evaluating them;
- A more effective interaction between the Climate-ADAPT platform – launched in 2012 to facilitate the spread of data on adaptation strategies implemented in the different EU States – and other national and local adaptation portals will be supported in order to strengthen the role of Climate-ADAPT;
- The Commission will ease the integration of adaptation measures under the Common Agricultural Policy, the Cohesion Policy and the Common Fisheries Policy;
- The construction of more resilient infrastructures will be encouraged;
- The Commission will foster insurance and other financial products for resilience in investment and business decisions.

As well as for the EU policy framework for energy and climate described above, the EU strategy on adaptation to climate change includes the development of indicators for monitoring and evaluating the effectiveness of adaptation actions.

In conclusion, the strategy aims at improving the resilience of the EU territory promoting the implementation of adaptation measures through the increase of the climate-related expenditure to at least 20% of the EU budget. These efforts represent a serious commitment from the European Union to address the issue of climate change, but they cannot be considered sufficient: current strategies seem to be mainly focused on some important factors (efficiency, cooperation and knowledge), ignoring others (diversity, redundancy, creativity), which could also be very significant in improving urban resilience (Galderisi, Ferrara 2012).

ELEMENTS FOR A NATIONAL STRATEGY ON ADAPTATION TO CLIMATE CHANGE

The lack of a coordinated national vision on adaptation strategy to climate change in Italy has been overcome with the adoption of the National Strategy in 2014. The final document provides a scenario of the possible consequences of climate change in different sectors – social, economic and environmental – and it defines a set of actions and adaptation measures to deal with those impacts. Therefore, its goal is to reduce risks due to global warming, to improve the ability of urban systems to adapt to them, as well as to take advantage of the possible opportunities that might be provided by new climate conditions.

The Strategy has been shared among all stakeholders, which have been involved in the process through an on-line survey in 2012 and with a number of meetings.

Twelve areas of actions or sectors have been identified because considered more at risk than others:

- Water resources;
- Hydrogeological instability;
- Forests;
- Coastal areas;
- Health;
- Infrastructures;
- Desertification;
- Biodiversity;
- Agriculture and fishing;
- Tourism;
- Urban settlements;
- Energy.

In addition to this list, two *special cases* have been added: the areas of Alps and Apennines and the hydrographical district of the Po river, considered relevant for their role in terms of impacts on environment and economy. For each sector a different number of actions have been defined, distinguishing between *grey, green* and *soft* measures, according to the White Paper "Adapting to climate change: Towards a European Framework for Action" (EC 2009).

In the final part of the Strategy, a critical analysis identifies the elements that are still missing to Italy for building an efficient adaptation system; those are a national platform on adaptation, the development of a national Plan and a reliable monitoring method to evaluate the progress achieved.

REFERENCES

European Commission, COM(2014) 15 final. A policy framework for climate and energy in the period from 2020 to 2030

European Commission, COM(2013) 216 final. An EU Strategy on adaptation to climate change

European Environmental Agency (12/2012). Climate change, impacts and vulnerability in Europe 2012

Galderisi, A., & Ferrara, F. (2012). Enhancing urban resilience in face of climate change: a methodological approach. *Tema. Journal Of Land Use, Mobility And Environment, 5*(2), 69-88. doi:http://dx.doi.org/10.6092/1970-9870/936

MATTM, Ministero dell'Ambiente e della Tutela del Territorio e del Mare (2014). Elementi per una Strategia Nazionale di Adattamento ai Cambiamenti Climatici.

IMAGE SOURCES

Fig. 1: https://www.flickr.com/photos/suburbanbloke/381634787/
Fig. 2: http://www.verdantix.com/blog/index.cfm/post/high-energy-costs-put-pressure-on-european-industrial-giants-73
Fig. 3: http://www.city-data.com/forum/weather/1842556-mean-yearly-highs-temperatures-europe.html
Fig. 4: http://en.wikipedia.org/wiki/UEFA_Euro_1968

04

CITIES, ENERGY AND CLIMATE CHANGE

REVIEW PAGES: URBAN PRACTICES

GENNARO ANGIELLO
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: gennaro.angiello@unina.it

In this number

PLANNING FOR ADAPTATION TO CLIMATE CHANGE: THREE CASE-STUDIES

According to the United Nations (UNFCCC, 1992), the climate change can be defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere". While debates, so noted in the mainstream media and in the academic literature, persist about whether or not climate change is due to anthropogenic causes (Hoffman, 2011), it is clear that new weather and climate patterns are emerging and that these changes are putting urban residents and settlements at risk (World Bank, 2010). Some cities have already seen changes in rainfall, resulting in more floods. Others have experienced changes in temperatures that have contributed to extended heat waves and droughts. Still others have encountered storm surges, coastal erosion, and the disappearance of wetlands (U.N.-Habitat, 2011). As these and other changes become more pronounced in the coming decades, they will likely present challenges to our urban environment (Salat and Bourdic, 2012).
The challenges imposed by the changing climate have been traditionally addressed from international and national initiatives under the umbrella of the United Nations Framework Convention on Climate Change and the Kyoto Protocol. However, in the last fifteen years, there has been a considerable effort to reframe this debate towards the local scale and focus on local causes and impacts of climate change (Urwin and Jordan, 2008). As a result, international and national programmes to assist local jurisdictions to develop local climate action plans emerged, and formal planning for climate change adaptation is rapidly accelerating (Baker et al., 2011). Today cities worldwide are increasingly recognizing the need to prepare for the impacts of climate change and, in the last decade, some have introduced new planning instruments finalized to ensure long-term, cost-effective adaptation measures. These measures are generally part of broader adaptation plans aimed to facilitate the adjustment of urban settlements and ecological systems to altered climate regimes. In this section, three relevant case studies of European cities that have recently developed climate change adaptation plans are illustrated:

- Copenhagen (Denmark);
- London (United Kingdom);
- Rotterdam (the Netherlands).

COPENHAGEN

Copenhagen is the capital and most populated city of Denmark, with an urban population of over 1,2 million. The city, well reputed for its initiatives aimed to combine economic growth and sustainability, is currently working towards achieving carbon neutrality while also preparing for the extreme weather expected in the next decades. In August 2011, the city approved the "Climate Adaptation Plan" aimed to prepare Copenhagen for the future by developing the Danish capital as a climate proof, attractive, and green city. The climate change adaptation plan has been developed to ensure adaptation measures are undertaken in the most cost-effective and efficient way. The plan is based on the analysis of a long-term scenario witch has led to the identification of the two must relevant threats resulting from climate change (City of Copenhagen, 2011):

- More and heavier downpours. The cloudbursts over the last few years have smacked the city budget. The heavy storm in 2011 alone cost the city over one billion of euros. Precipitation in Copenhagen is expected to increase by 30 to 40% by 2100.
- The rise of the sea level. With most of the city only having an average altitude of 9 meters above the sea level and with a significant number of people and amount of property lying close to the water level, Copenhagen is potentially vulnerable to the effects of natural variability in sea level and, on decadal timescales, anthropogenic sea level rise. Water levels around the city are likely to rise by up to 1 metre over the next hundred years.

Regardless the issue of the increasing precipitations, two main and complementary strategies have been identified. The first deals with the improvement of the drainage systems, so that they will be capable of coping with major downpours. To this end, a range of tools will be used for better rainwater management including rain and sewage reservoirs, permeable paving, filters and infiltration trenches and other sustainable urban drainage tools. The second strategy deals with the improvement and the connection of the urban green areas. The number of green areas – including 'pocket' parks, and green roofs and walls – will be increased to slow rainfall run-off. Green roofs not only will capture 60% of rainfall, but will also improve air quality, vegetation and wildlife habitat, while reducing urban heat-island effects. Regardless the issue of the rise of the sea level, there is an option to establish a barrier at Nordhavnen and Kalveboderne and to raise the rest of the coastline out towards Øresund. The barriers will be established so that they will protect the city against storm-surge events but without disrupting harbour operation at the same time. The plan take into consideration the future urban expansion and proposes that new constructions and new buildings in areas that are at risk of flooding from the sea and rising groundwater levels will be equipped and designed considering site-specific solutions. An interesting aspect of the plan is that adaptation is not only considered as a negative measure but also as an occasion to increase the quality of life for the city's inhabitants and create synergies with other planning initiatives. For instance, the "green" perspective embodied in the adaptation plan, while increasing the urban resilience, is expected to attract new private investments and, at the same time, expand and improve the quality of public spaces. The plan is the result of a 2 years public hearing and political discussions during witch detailed studies of the most relevant topics was executed together with stakeholder involvement as basis for the new climate change adaptation plan including risk assessments and economical consequences as well as suggestions for specific projects for implementation. Positive impacts of the adaptation plan will occur in the next decades. However, the plan provides a robust economic argument for timely and preventative measures for adaptation to the changing climate.

LONDON

London is the capital and most populous city of England and the United Kingdom, with an urban population of more then 9,7 million. As one of the top financial centres in the World, London is considered an alpha world city in the global economic system. The city has a long tradition of planning and revitalization projects aimed to promote sustainable development, including mitigating and adapting to the impacts of climate change, as well as promoting health and equality.

In October 2011, the city approved the "Climate Change Adaptation Strategy" as part of a series of strategies that together set out actions and policies to make London a sustainable and climate-resilient city. The strategy outlines a series of proposed actions the city should take in order to meet the challenges of climate change. Based on the analysis of a long-term scenario, the plan identifies three must relevant issues related to future changing climate (City of London, 2011):

- Flood risk. The UK Environment Agency has undertaken a study to identify the flood risk management options to protect London and the Thames Estuary from tidal flooding to 2100. Different adaptive measures were identified from raising the height of existing defences to constructing a second Thames Barrier. The thresholds to protection against rising sea levels provided by each of the options have been plotted against sea level rise. This approach helped decision makers to understand the suite of options open to them and how they can be combined into a 'decision pathways' that create a portfolio of measures through the century.
- Water resource scarcity. Over 600 million liters of treated water per day, nearly a quarter of all the water distributed in the mains network, is lost in leakage. This is due to the fact that nearly a third of the pipes that make up the distribution network are more than150 years old. To prevent water resource scarcity, the plan adopted a solution, referred to as 'water neutrality'. In principle, this means no net increase in demand despite a growth in the number of Londoners. To this aim, efficiency measures are planned for Londoners' homes at no cost to the householder.
- Ground condition. London's urban realm and land cover intensify many of the climate impacts. For example, the traditional construction of roads and buildings causes the loss of permeability and increase the risk of flash flooding while the loss of vegetation helps create the heat island effect. In this regard, the plan sets a target of increasing green cover in central London by 10% by 2050. The urban greening will help cool the city in summer and reduce the frequency and intensity of floods.

A number of cross cutting issues have been taken in consideration in the adaptation plan. These include the assessment of the consequences of climate change for urban systems such as health, well-being and economy. London's work on adaptation has benefited from strong and consistent political support, which has been the driving force for the setting up of other enabling factors such as financial support and a coordination unit in the form of the London Climate Change Partnership. An interesting aspect of the plan is the strong engagement of the city's residents. In this regard, digital media channels have been intensively used to ask Londoners what they could and should do to adapt. This included YouTube movies starring the Mayor and an interactive website where Londoners can give their ideas and vote on other peoples' ideas. This allowed a wide audience engagement in policy development and helped raise both awareness of the issue and ownership of the risk.

ROTTERDAM

Rotterdam is a thriving world port city with an urban population of over 1 million. The city has a long tradition of continually adapting to new circumstances and anticipating and benefitting from economic and social change.

In December 2012, the city adopted the "Climate Change Adaptation Strategy" that sets the course that will lead to a climate-proof city and provides insight into the opportunities that climate change presents. The Strategy provides the framework and the starting point for a future-proof development of Rotterdam and ensures that, in the future, topics such as water safety, accessibility and the robustness of the city are included as the basis for each (spatial) development right from the start of the process. The plan is based on the analysis of a long-term scenario and addresses five main themes:

- Flood management. Rotterdam is located in the delta of the rivers Rhine and Meuse. The vulnerability of Rotterdam to flooding is illustrated by several events in the 20th century. Rotterdam needs to be protected against flooding, both inside and outside the dykes. To this aim, the plan provide the construction of flood defensive works and high levelled embankments in order to protect the city against rising sea levels and make the Rotterdam harbour one of the safest ports in the world. Above this "structural" measures many others small-scale interventions have been proposed. These include water squares which relieve the sewage system, infiltration zones along infrastructures and the integration of trees and greenery in outdoor areas (both public and private), which also benefits the city environment. By frequently applying these small-scale measures to the 'capillaries of the city', the plan aims to reduce Rotterdam's vulnerability.
- Accessibility. Accessibility of the city and the port is recognized as an important aspect of the climate for establishing a business. If water plays a more significant role in spatial planning and more housing accommodation is realized on the water, by consequence, transport over water should equally be stepped up. By 2025, the transport infrastructure of the city and port will be climate proof and an intensive public transport network over water will contribute significantly to the accessibility of the city
- Urban water security. Climate change can lead to increased precipitation, but also to longer periods of aridity. In order to guarantee water security, flexible water level management in watercourses and ponds will be used to realize additional seasonal storage. In addition, large diameter water connections to the regional water system will be constructed to increase the supply of fresh water.
- Adaptive buildings. One of the objectives of the Rotterdam City Vision (2007) is to realize densely populated residential environments in the port areas in and around the city centre. Building in these areas requires a proactive response to the effects of climate change. In this regards, in two pilot areas of the city, the test of adaptive construction methods is ongoing. The results of the pilots will be used to develop new planning guidelines for future developments.
- City climate. The city climate is influenced by the layout and design of the city. In this regards, the plan stresses the need to pay attention in the future to the distribution of green/blue areas, heat stress resistance, presence of sheltered and cool places in the open space.

One of the most interesting aspect of the plan is that it seeks to find a balance between civil engineering and naturally functioning biological components, in order to make optimal use of potential ecosystem services and functions for the benefit of safety against flooding and freshwater availability.

The climate change adaptation strategy offers many opportunities to strengthen the economy of the city and the port, to improve the quality of life in neighborhoods and districts, to increase biodiversity in the city and to foster committed and active participation by Rotterdam residents in society.

REFERENCES

Baker, I., Peterson, A., Brown, G., & McAlpine, C. (2012). Local government response to the impacts of climate change: An evaluation of local climate adaptation plans. *Landscape and urban planning*, 107(2), 127-136.

City of Copenhagen (2011). Copenhagen Climate Adaptation Plan. Available at: http://en.klimatilpasning.dk/media/568851/copenhagen_adaption_plan.pdf

City of London (2011). Managing risk and increasing resilience. The Mayor's Climate Change adaptation Strategy. Available at: https://www.london.gov.uk/sites/default/files/Adaptation-oct11.pdf

Hoffman, A. J. (2011). Talking past each other? Cultural framing of skeptical and convinced logics in the climate change debate. *Organization & Environment*, 24(1), 3-33.

Salat, S., & Bourdic, L. (2012). Systemic resilience of complex urban systems. *TeMA. Journal of Land Use, Mobility and Environment*, 5(2), 55-68.

United Nations (2011). Global report on human settlements 2011: *Cities and Climate Change*. United Nation, Nairobi.

United Nation (1992). *United Nations Framework Convention on Climate Change*. United Nation, Geneva, Switzerland.

Urwin, K., & Jordan, A. (2008). Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environmental Change*, 18(1), 180-191.

World Bank (2010). *World Development report 2010: development in a changing climate*. World Bank, Washington, DC

IMAGE SOURCES

The image shown in the first page is from http://www.grist.org; the image shown in the second page is from http://e-architect.co.uk; the image shown in the third page is from http://www.wikipedia.org; the image in the fourth page is from http://www.holland.com.

05

CITIES, ENERGY AND CLIMATE CHANGE

REVIEW PAGES: NEWS AND EVENTS

ANDREA TULISI
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: andrea.tulisi@unina.it

In this number

SOLUTION SHARING STANDPOINT FOR THE CLIMATE CHANGE CHALLENGE

From the next November 30 until December 11, Paris will host the 21st Conference of the Parties (COP21); it represents an important step towards reaching a universal climate agreement by adopting and implementing new legal and political instruments applicable to all the members of the United Nations Framework Convention on Climate Change (UNFCCC). The main goal is keeping global warming below 2 degrees Celsius above preindustrial temperatures by reducing global emissions of greenhouse gases.

After almost 20 years from the Kyoto protocol, in fact, the issue of climate change is increasingly present, as demonstrated by the 35-page of Summary for Policymakers of the Fifth Assessment Report, which confirm the robustness of scientific hypotheses about the planet climate changes occurred in the last century and the alarming expectations for the next decades. New evidence strengthens and confirms the data on climate change as result of an extensive series of scientific observations and models of new generation (IPCC, 2014). We can therefore say with a "very high level of confidence" that:

- Since the 1950s, many of the observed changes are unprecedented over decades to millennia;
- Human influence on the climate system is clear, and the main reason is linked to the emissions of greenhouse gases in the atmosphere.

There are two kind of strategies to face with those issues:

- preventive strategies through mitigation measures aimed at reducing GHG emissions;
- prefigurative strategies through the development of resilient systems (Colucci, 2012).

Till now the main approach used by the UNFCCC was based on a burden-sharing standpoint more than a solution sharing one; one of the most interesting news introduced in the COP21 is the *Agenda of Solutions* that propose a different approach to the climate change consisting in a "set of tangible initiatives and a demonstration of what is feasible by pioneers, encouraging all stakeholders to take action, share best practices and knowledge around low-carbon solutions, and contribute to the resilience of economies and the development of structuring projects" (www.cop21.gouv.fr). Therefore, the experience exchange became one of the crucial tools of this challenge.

In this perspective were selected some international events taking place in the coming months, that will contribute to the networking of experience, knowledge and best practices on the issue of climate change, thus enriching the topics of Paris conference.

RESILIENT CITIES 2015

Where: Bonn – Germany
When: 8 - 10 June 2015
http://resilient-cities.iclei.org/

Diversity of thoughts and approaches is the core of "Resilient Cities", the Annual Global Forum on Urban Resilience and Adaptation, hosted every year in Bonn. This International Congress, now in its fifth edition was created in 2010 thanks to the collaboration of Local Governments for Sustainability (ICLEI), with the World Mayors Council on Climate Change and the City of Bonn, the aim of the initiative was to create a network between members of the institutions and experts on the issues of the urban environment resilience. Mayors, councillors, commissioners and governors chiefs of sustainability, as well as global climate change and adaptation experts, urban regional planners, university students and researchers are invited to discuss together about a wide variety of topics; the main topics of the 2015 edition are:

- Urban risk and vulnerability including risk data and analysis;
- Adaptation planning and policy and integrated approaches;
- Communicating resilience and applying ICT solutions;
- Ecosystem-based adaptation and resource security;
- Creating resilient public health systems and communities;
- Resilient building, design and infrastructure;
- Capacity building, Governance and Collaboration;
- Financing resilience planning and development.

THE 2ND INTERNATIONAL CONFERENCE "CHANGING CITIES"

Where: Porto Heli – Greece
When: 22 - 26 June 2015
http://changingcities.prd.uth.gr/

The strategic role played by the urban development to address the climate change challenge is also one of the main topic of the 2nd international conference "Changing Cities", organized by the Department of Planning and Regional Development, University of Thessaly, under the aegis of the Greek Ministry of Environment, Energy & Climate Change.

The main conference themes come from the observation of the social, economical and environmental urban phenomena occurred in the last decades like the rise of post-industrial urban economies (mainly involving ICTs and leisure activities) or the formation of a multi-ethic and multi-cultural urban societies; those issues are closely related with the emerging new patterns of urban space morphology and landscape and represent the basis on which urban planners and designers, architects, landscape designers, urban geographers, urban economists, urban sociologists, and demographers, are called to investigate and propose ideas, visions and new challenges concerning cities and their future. In particular, this edition main topic is "planning and designing resilient cities under economic and environmental uncertainty"; it invites to reflect that the urban resilient strategies to be effective have to face also with economic and social contingencies.

OUR COMMON FUTURE UNDER CLIMATE CHANGE

Where: Paris – France
When: 7 - 10 July 2015
http://www.commonfuture-paris2015.org/

A similar concept is expressed in the call of the Conference "Our Common Future Under Climate Change", focused more on key issues concerning climate change in the broader context of global change. Also in this case the measures for climate phenomena are seen as closely connected to political and economical uncertainties; for this reason one of the key point of the conference is about the effort to "identify areas of consensus, and map controversies while taking stock of the multiple connections to development and environmental challenges within a large diversity of local, national and regional contexts" (www.commonfuture-paris2015.org). Therefore, a large emphasis is placed on transdisciplinary and integrative approaches, able to join different stakeholders and communities, thus encouraging multi-disciplinary and multi-lateral thinking. On these bases, the structure of the conference is organized in four daily themes:

- state of knowledge on climate change;
- landscape of our common future;
- responding to climate change challenges;
- collective actions and transformative solutions.

It starts with a session on the latest knowledge from both natural and social sciences and closes by exploring transformative solutions to climate change from different perspectives in order to reach integrated and shared solutions.

10TH CONFERENCE ON SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

Where: Dubrovnik – Croatia
When: September 27 - October 3 2015
http://www.dubrovnik2015.sdewes.org/

One of the main issues concerning climate change challenge is related to the sustainable use of natural resources and the development of new knowledge based economy, taking into account methods for assessing and measuring sustainability of development, regarding energy, transport, water, environment and food production systems and their many combinations. The "10th Conference on Sustainable Development of Energy, Water and Environment Systems" is focused on the improvement and dissemination of methods, policies and technologies about sustainability. In this direction the conference proposes wide array of topics amongst which it is worth mentioning: green economy and better governance; decarbonisation policies; energy, transport, water and environmental policies; technology transfer and development; sustainable resilience of systems; smart energy systems; energy planning; transport management; renewable energy resources; energy markets; emission markets; political aspects of sustainable development. In particular, the Conference will address the core goals of the Energy Community like the creation of a competitive integrated regional energy market or the development of the Mediterranean power ring.

REFERENCES

Colucci, A. (2012). Towards resilient cities. Comparing approaches/strategies. *Tema. Journal Of Land Use, Mobility And Environment*, 5(2), 101-116. doi: http://dx.doi.org/10.6092/1970-9870/921

IPCC, (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

WEB-SITES

Paris 2015, 21st Conference of the Parties: www.cop21.gouv.fr/en/choice-france/agenda-solutions

"Our Common Future Under Climate Change" Conference: www.commonfuture-paris2015.org

IMAGE SOURCES

The image shown in the first page is taken from: www.nextjuggernaut.com

AUTHORS' PROFILES

Raffaella Niglio

Architect, she received a master's degree with honors from the University of Naples Federico II with a thesis in Architectural and Urban Design. She operates in the field of sustainable buildings and environments and since 2014 she works with the Department of Civil, Architectural and Environmental Engineering within the research project Smart Energy Master investigating the "smart" performance of the Metropolitan City of Bari, Italy.

Laura Russo

Engineer, Ph.D. student in Civil Systems Engineering at University of Naples Federico II. She received a master's degree in Architecture and Building Engineering with a thesis on urban expansion and the sprawl phenomena, with particular attention for Campania. Since 2014, she works at the Department of Civil, Architectural and Environmental Engineering – University of Naples Federico II – within the European project "Smart Energy Master" and her research activity is focused on the complex and multidimensional relationship between the city and energy consumption.

Gerardo Carpentieri

Engineer, Ph.D. student in Civil Systems Engineering at University of Naples Federico II. He received a master's degree in Environmental and Land Engineering with a thesis on the integrated government of land use and mobility for environmental sustainability in the metropolitan areas. In July 2013 he won a scholarship within the PRIN project on the "Impacts of mobility policies on urban transformability, environment and property market". He is currently involved in the research project "Smart Energy Master" at the Department of Civil, Architectural and Environmental Engineering – University of Naples Federico II.

Gennaro Angiello

Engineer, Ph.D. student in Civil Systems Engineering at the Federico II University of Naples. His research interests are in the field of accessibility analysis and modeling, land-use and transport interactions and sustainable mobility. He is currently involved in the research project Smart Energy Master and in the COST Action TU1002 accessibility Instruments for Planning Practice in Europe.

Andrea Tulisi

Architect, graduated in Architecture from the University Federico II in Naples in 2006. In January 2014 he holds a PhD in Environmental Technology with a research focus on rehabilitation strategies for semi-enclosed spaces in the "Compact City". He is currently involved within the project Smart Energy Master with DICEA department of the University of Naples Federico II; his research activity is focused on the link between urban open spaces and energy consumption.