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Urban sprawl processes characterize the landscape of the areas surrounding cities. These landscapes show different features according to the geographical area that cities belong to, though some common factors can be identified: land consumption, indifference to the peculiarities of the context, homogeneity of activities and building typologies, mobility needs exasperatedly delegated to private cars.

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TOWARDS RESILIENT CITIES

COMPARING APPROACHES/STRATEGIES

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ABSTRACT

The term “resilience” is used in many disciplines with different meanings. We will adopt the ecological concept of resilience, which epitomises the capacity of a system to adapt itself in response to the action of a force, achieving a state of equilibrium different from the original (White, 2011).
Since the end of the last century, with a significant increase over the last few years, resilience has featured as key concept in many technical, political papers and documents, and appears in many researches. Of all this recent and varied range of literature, our focus is on those texts that combine resilience with strategies, processes and models for resilient cities, communities and regions.
Starting from the resilience strategies developed as response for risks mitigation, the paper thus explores other approaches and experiences on cities resilience that have been conducted: the aim is to compare and identify innovation in the planning process towards risks mitigation.
In this paper we present a summary of the initial survey stage of our research, with three main aims:

- understanding the approaches to resilience developed so far and identifying which aspects these approaches share (or not);
- understanding which strategies are being proposed for resilient regions, cities or social-ecological systems;
- understanding whether proposed resilience strategies involve innovations in urban and regional development disciplines.

The aim is to understand whether the proposed concept of resilience, or rather strategies, constitute progress and contribute to innovation in the areas of urban planning and design in relation to risk mitigation.

KEYWORDS:
Resilience, Urban Planning, Risk Mitigation

1 ADOPTING RESILIENCE

The concept of resilience, and the term itself, is used in many disciplines (from engineering to the natural sciences, psychology and sociology) with meanings that are not always the same.

In the discipline of ecology, from which the agreed term used here is taken (and which, in a nutshell, epitomises the capacity of a system to adapt itself in response to the action of a force, achieving a state of equilibrium different from the one it originally had), resilience has been defined and explained in different way, and has evolved in line with the innovations that have occurred in that discipline (White 2011).

Generally speaking, we have seen this concept become widespread in recent years, often used as a key concept in many documents and books, at conferences and on websites. More recently, resilience has been used also when shaping development strategies for cities, and defining alternative development models for urban systems, local communities or social-ecological systems on a considerably bigger scale.

The concept of ecological resilience, as it relates to the development of territorial systems, was officially introduced into international politics and the European Union in 2005 when the document *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations*[1] was first presented.

The ongoing research presented here focuses on the concept of resilience with regard to the development of regions, cities and local communities.

While not claiming to be complete, in terms of the widespread disciplinary and political/social interest, this paper presents a summary of the first stage of the work carried out, and consists in a comparison of the wide-ranging literature published on the concept of resilience and cities (and/or resilience and regional systems).

The research, in relation to which this paper presents a summary of the initial survey stage, has three main aims:

1) Understanding the approaches to resilience developed so far, and identifying which aspects (concepts, strategies and so on) of these approaches are shared (or not shared);

2) Understanding which strategies are being proposed for resilient regions, cities or social-ecological systems (and pointing out the shared strategies);

3) Understanding whether the resilience strategies proposed involve innovations in f urban and regional development disciplinary fields.

The research aim is to comprehend whether the concept of resilience, or rather, whether the strategies of resilience proposed constitute progress and contribute to innovation in the areas of urban planning and design.

Three main families of literature have been identified from the recent literature promoting resilience as a key strategy. For each of these families the aim of the research – at this early stage – was to understand which particular concept and which aspects of resilience are used, which resilience strategies are proposed, how the term 'city' is defined and interpreted and, consequently, which are the key concepts related to strategies for resilient cities.

1.2 HOW CAN RESILIENCE BE DEFINED?

The concept of resilience has two main definitions involving different visions and approaches with regard to the concept of stability (Holling and Gunderson 2002). The most common established definition may be

[1] *Building Adaptive Capacity in a World of Transformations* (Background paper to WSSD) is a technical-scientific paper in support of the Swedish Government's Environmental and Scientific Advisory Council during the World Summit on Sustainable Development

called 'engineering resilience': in physics (and engineering), the resilience of a material is the property that enables it to resume its original shape after being deformed. This definition recalls the concepts of control, consistency and predictability.

The second definition, 'ecosystem resilience' is based on the concepts of persistence, change/unpredictability, adaptability and variability, emphasising conditions that are far from *aequilibrium*. Resilience is the property of complex systems to react to stress phenomena by activating response and adaptation strategies in order to restore the mechanisms by which they function. Resilient systems under stress react by regenerating themselves while maintaining the functionality and recognisability of the systems. Thus, resilience does not imply the restoration to an initial state, but the restoration of functionality through change and adaptation.

In ecology, resilience derives from functional strengthening through the various levels and hierarchies and from functional overlap between the levels. The vulnerability of the systems gradually increases as the sources of regeneration (diversity, redundancy, functional overlap and so on) and functional diversity are reduced (Odum 1963; Bettini 2004).

This article refers to the concept of ecosystem resilience, and all the papers and documents consulted refer to this agreed notion of resilience.

2 THE LITERATURE: FAMILIES AND APPROACHES

Since the end of the last century, and with a significant increase over the last few years, resilience as a key concept has featured in many technical and political papers and documents, and in a great deal of research that has been undertaken. The paper focuses on the texts that combine resilience with strategies, processes and models for the development of cities, communities and regions.

It is possible to identify three main families within the literature (to which can be added best practices, documents of intent and a large number of websites as research platforms, sharing of experience, networks of best practices and so on):

A) Resilience and sustainability: the concept of resilience is used as a way to gain the sustainability of the development of social-ecological systems.

B) Resilience and adaptation: the resilience is used as the key concept to the adaptation strategies with regard to climate change, natural resources reduction and the quality of local communities.

C) Resilience and territorial risks: resilience is used as a key concept for the innovation of territorial risk mitigation/management strategies (with the integration between the risk mitigation goals and the regional quality goals).

Assigning the contributions of the different authors to one of these three families has inevitably been forced in some cases. As we shall see, many concepts and strategies are common and shared, and, while the family of origin can still be identified, there is often intertwining and overlapping.

3 RESILIENCE AND SUSTAINABILITY

Although to do so is a gross simplification, it is possible to relate the first group of authors at The Resilience Alliance[2], a multidisciplinary network of researchers that brings together various universities and research

[2] The Resilience Alliance is a research organisation comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of social-ecological systems. The body of knowledge developed by the RA, encompasses key concepts of resilience, adaptability and transformability and provides a foundation for sustainable development policy and practice, http://www.resalliance.org/.

centres promoting regional and local development policies and processes based on resilience. The family of texts is undoubtedly very large, and includes such authors as Carl Folke, Lance Gunderson, CS Buzz Holling, Elinor Ostrom, Johan Colding, Fikret Berkes, and numerous others.

Resilience is used as a key concept to achieve sustainable development. These days, sustainability has an established, common definition, or rather, several established institutional definitions[3]. While accepting the definition of sustainability as a given, the debate on the different routes to ensuring sustainable development is certainly more complex. The approach to complex systems and resilience is part of this debate.

In particular, the authors belonging to this school starkly oppose the approaches based on optimising the management of natural and social resources. More specifically, several authors (Folke, Berkes, Gunderson and others) stress that the optimisation is not a solution or the only solution: it is not possible to consider optimising the mechanisms of the way in which complex systems operate as a long-term strategy[4].

The concepts of efficiency and optimisation, are not negative in themselves, but absolutely necessary. They represent a loss of resilience and complexity if they are the only objectives or principles of reference for intervention policies and strategies.

It is possible to single out a substantial interdisciplinary core from the texts consistent with this approach, with most authors having a background in the natural and ecological sciences, and social and economic disciplines.

The common distinguishing features of a huge and complex range of authors, research and experiences, are:

- a sizeable theoretical output integrated with their application in different contexts;
- the central role of, and sharing of all experiences, texts and research on, the ecosystem approach, and its integration with the social dimension;
- a large scientific output (theoretical, methodological – modelling – and application) concerning the sustainable management of natural resources in which the sustainable management of natural resources is integrated with the social aspects of local communities;
- considerable attention to the development of local communities and regions in crisis.

Furthermore, it is important to point out that no specific significance can be found on the topic of the city, or rather urban design.

3.1 CONCEPTS OF ECOSYSTEM RESILIENCE

'Resilience, the capacity to lead to a continued existence by Incorporating change' (Folke, Colding and Berkes 2003, p.352)

Of the three families of authors, this is the one that chiefly integrates the concepts and principles related to ecosystem theories into strategies for the development of socio-ecological systems. The resilience strategies proposed are based on the concepts and properties of the ecosystems connected with resilience.

Diversity and stability

The diversity and 'creative' redundancy of functions are fundamental to ensure the mechanisms of resilience (Low, Ostrom, Simon and Wilson 2003).

Resilience, on a regional or complex scale is produced by the replication of processes on different scales. This apparent redundancy of similar functions replicated at different, interacting scales increases and

[3] While not wishing to deal here with the definition of sustainability, we would refer to sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (1987 Brundtland Report, World Commission on Environment and Development (WCED)).

[4] The theoretical debate on the optimisation is developed by different authors (Low et al. 2003, Walker and Salt 2002, Gunderson and Holling 2002, and others).

guarantees complex systems a high level of resilience. While disturbance factors or crises are able to eliminate populations, or even entire ecosystems, the overall system is capable of reorganising itself due to the fact that functions similar to those lost can be found in other populations or ecosystems. The importance of diversity and redundancy for the functioning of natural systems has been studied and demonstrated, just as there are numerous studies on the effectiveness of redundancy for the smooth running of social systems: redundancy in public services, the presence of a large number of systems of governance, the strength and complexity of socio-political systems based on a redundancy and local management (Low, Ostrom, Simon and Wilson 2003).

Ecosystem organisation

Numerous empirical studies have identified a number of key concepts and mechanisms underlying complex natural systems, response systems to disturbances, and the structure and functioning of ecosystems.

Ecosystems do not have a single equilibrium with homeostatic controls to prevent them from deviating far from this, but multiple equilibria commonly define functionally different states. The normal movements of variation among the states maintain structure, resilience and diversity. In fact, non-linear characteristics of the processes of predation, reproduction, competition and the dynamics of nutrients create multiple equilibria.

Ecological organisation can be seen as a 'hierarchy' in which the hierarchical levels have their own different temporal and spatial attributes. The cycles of birth, growth, death and renewal transform and change hierarchies from a fixed or static state to a dynamic adaptive one.

Gunderson and Holling introduced the concept of *panarchy*[5] (in preference to hierarchy) to explain this concept and the interconnection between the different cycles and systems (with different complexity).

Cycles of adaptation

Complex systems are self-organised: self-organisation occurs when the properties of the macroscopic system that arise from the interactions between components are activated and influence the later stages of growth and the interaction processes themselves. It is the mechanisms of self-organisation that, by becoming activated, open up to multiple possible evolutionary pathways, and thereby maintain systems that have drifted far away from their equilibrium.

3.2 RESILIENCE STRATEGIES: LIFE IS FULL OF SURPRISES

On the basis of experiments and studies, different strategies have been devised for identifying a means to sustainability that embraces the dynamic nature of complex systems. The survival of social systems is more likely if the natural systems to which they linked are efficient and function properly (the interdependence between natural and social systems is a topic that has been widely debated).

'Ecological resilience has been defined as the magnitude of disturbance that can be experienced before a system moves into a different state and different set of controls. Social resilience has been defined as the ability of human communities to withstand external shocks to their social infrastructures, such as environmental variability or social, economic, and political upheavals. […]. The challenge is to anticipate

[5] Gunderson and Holling introduced the concept of Panarchy, or a cyclical and organisational trend in ecosystems comprising four phases: rapid growth (phase r), conservation (phase K), release (omega phase) and reorganisation (alpha phase). The adaptive cycle describes how an ecosystem self-organises, and how it changes and responds to external stresses and to changes in the world. A good example of the adaptive cycle in ecosystems are the cycles that characterise the North American forests, in which every 40-50 years parts of the forest (not all forests) catch fire naturally. The overall forest system consists in components and distribution areas of systems at different states in the evolutionary cycle. The cycles are not absolute, fixed and irrevocable, but an outline. In reality, both in natural ecosystems and social systems, there are transitions between the phases and between the conservation and reconstruction cycles.

change and shape it for sustainability in a manner that does not lead to loss of future options. It involves enhancing the capacity for self-organisation.' (Folke, Colding and Berkes 2003, p.354).

Learning to live with uncertainty and change

Precisely because changes and crises are part of the evolutionary processes of complex systems, one of the key strategies for maintaining and improving the mechanisms of resilience is specifically to cope with the phenomena of change rather than trying (or rather, struggling under the illusion) to remove the possible causes and phenomena of change.

For this reason, one of the strategies for increasing resilience and adaptability is to live with uncertainty and expect the unexpected, setting in motion courses of action that make it possible to accumulate experience. In this way, by implementing adaptation strategies, crises can be overcome and approximate the phenomena of surprise, keeping open a wide range of options and possibilities.

Feeding diversity for reorganisation and renewal

Increasing diversity is another strategy common to many studies and experiences. If it is by now well-established and known that diversity is an asset that must be cultivated in all systems (we might recall the policies for biodiversity, and in other areas, for governance), redundancy is a concept that has received less attention. Diversity and redundancy are the immediate sources for replacing functions that have been lost following a disturbance event, and form the 'stock' from which to draw adaptive responses with regard to a multiplicity of temporal and spatial dimensions.

Memory

In natural ecosystems, diversity and functional relationships are guided by mechanisms of ecological memory, which plays a role in putting together and spreading organisms and their interactions in space and time, and storing experience appropriated as environmental conditions fluctuate[6]. It is therefore not only the presence of diversity and redundancy that ensures increased resilience, but also the implementation of adaptive responses with regard to the phenomena of change.

Combining different types and systems of knowledge and creating opportunities for self-organisation

This concept is associated with the importance of bringing together and incorporating different forms of knowledge. This approach is even more important when applied to social systems: in risk management and community experiences that have occurred under extreme conditions (communities in geographic areas experiencing extremely difficult environmental conditions), it proved a key strategy to include the study of knowledge and local traditions in the cognitive phase in addition to scientific cognitive methods. In fact, traditional local knowledge encompasses the memory of responses implemented in order to adapt to environmental conditions and to changes.

3.3 CITY MODEL

The Urban Resilience program[7] is a research project started in 2007 with the aim of understanding what levels of stress can be absorbed by urban social-ecological systems without their structure and functionality mutating into less desirable forms. The research project does not explicitly provide a comparison with themes and instruments of local governance processes. The resilience-city model is based on four "systems":

[6] In the highly simplified landscapes of ecosystems, we see a loss of the mechanisms underlying ecological memory.

[7] CSIRO, Australia; Arizona State University, USA; Stockholm University, Sweden, Urban Resilience Research Prospectus Coordinatore *Brian Walker* Science Program Director and Chair, Board of Members The Resilience Alliance, February 2007 (go to link 1172764197_urbanresilienceresearchprospectusv7feb07.pdf)

the metabolic flows (that support the urban functions, human well-being and quality of life), the governance networks, the social dynamics and the built environment.

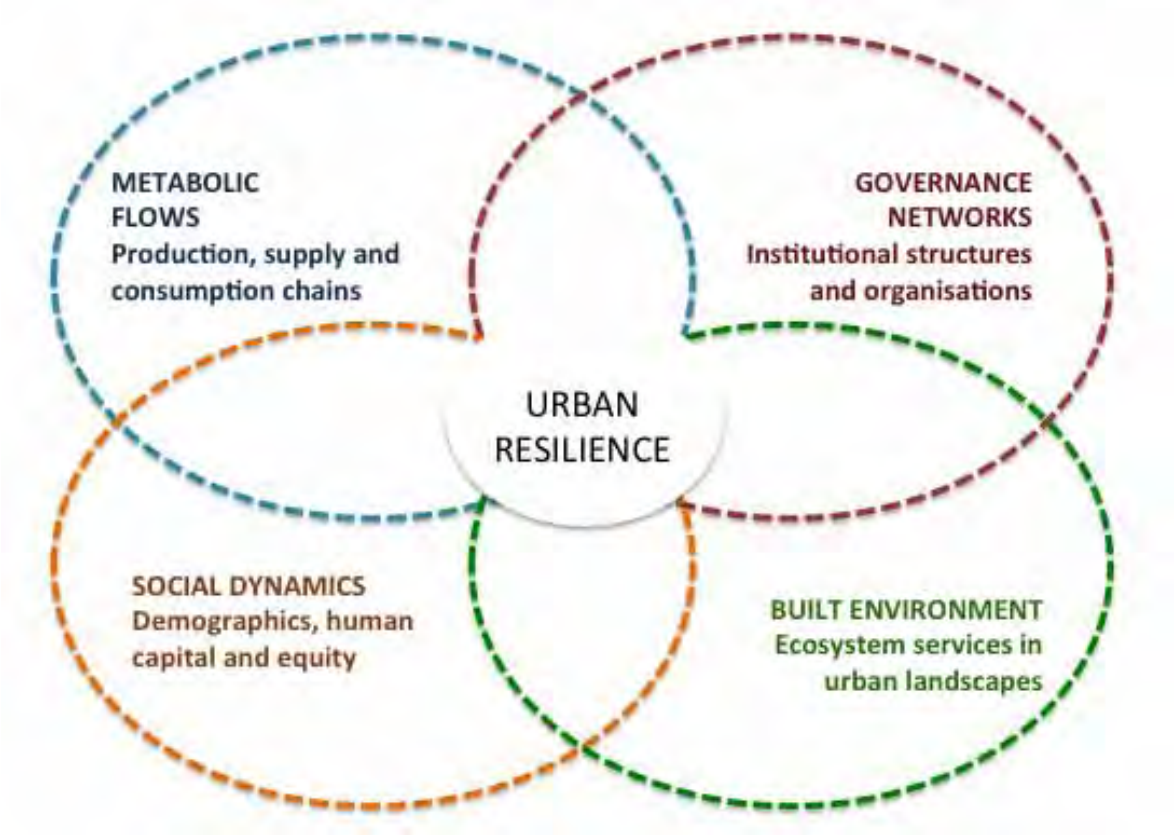

Fig. 1 The four components the overall urban system (adapted from http://www.resalliance.org)

4 RESILIENCE AND ADAPTATION

The amount of literature and documents related to climate change adaptation strategies and peak oil is enormous, including with regard to the relevance of the issue. The bodies and international organisations that deal with this issue are also many. For the purposes of this work, we have chosen from the wide range available texts that identify within resilience the concept on which adaptation strategies primarily related to urban and regional contexts may be built.

It is possible to identify two main groups: there are a number of texts on the resilience of urban areas or regions (such as those by Stephen Coyle or texts by authors such as Peter Newman, Peter Beatley, Heather Boyer) and many experiences, and a number of texts that refer to the initiatives carried out in English Transition Cities (Rob Hopkins and Shaun Chamberlin). Moreover, many documents by international institutions such as the World Health Organisation (WHO), the United Nations Environment Programme (UNEP), the UN and European Union documents of intent are included in this family.

One aspect common to these texts is that of using resilience as a key for coping with the important changes taking place, and for building adaptation strategies for climate change, the lack of – and fall-off in – natural resources (particularly oil), and energy crises.

This group of authors is particularly relevant to the lines of research because they focus on the development of cities, urban areas based on sustainable settlement models.

In terms of their core disciplines, there are some authors (whose works are very recognisable) who come from planning and urban design backgrounds, while others have a background in the natural sciences and economic and social sciences, and a few come from political and strategic sciences backgrounds.
The development scenario or model based on resilience strategies (resilient city) emerges as the most desirable and, in some texts (Newman), the only one.

4.1 CONCEPTS OF ECOSYSTEM RESILIENCE

In terms of using and referring to the concepts specifically related to resilience, the works focussing on cities and adaptation (e.g. Newman) do not expand upon theoretical references and/or close examination of the properties or principles of ecosystem resilience, while in the works related to transition cities, numerous concepts related to ecosystem resilience and properties are explicitly mentioned: diversity and redundancy, modularity and hierarchies/organisation and feedback processes. These principles are the basis for constructing processes, strategies and actions for resilient communities.
In general, it is possible to highlight how both the strategies and the instruments used in the texts, with the exception of the Transition Cities initiatives, can be attributed to principles, methods and tools already developed in the context of environmental and ecological planning. These texts are relevant from the viewpoint of innovation and the process models proposed but mainly refer to the concepts and principles already expounded within the debate on adaptation strategies. One element of innovation, from the point of view of the discipline of planning and urban design, is the change in principles, models and recognised experience at the level of urban systems.
The English Transition City initiatives (now spread throughout the world) are, however, very closely linked to the principles and concepts characteristic of resilience. These experiences, based on theoretical references set out in the texts, demonstrate highly innovative aspects focused, in particular, on the process, bottom-up policies and active participation and empowerment of local social communities.

4.2 RESILIENCE STRATEGIES

One element common to all the works of this family is their innovative approach and the attention they give to construction of the process, which includes both aspects of population involvement, and technical and operational aspects. Hopkins, in construction of the process, employs a number of concepts related to resilience theories (in particular, feedback processes). The main concepts of resilience referred to in the definition of strategies and actions (policies) for the transitions cities are: diversity (and creative redundancy), modularity (with particular reference to organisational networks and relationships as applied to the policies of governance), local-based (similar and related both to the vision of the complexity of urban regional systems, and to the importance of cognitive elements and bringing citizenship and local communities into effect), as well as the importance of choosing and implementing solutions appropriate to local contexts without generalising and defining methodologies to be reproduced in the same way in different contexts), and the concept of small (which refers to the balance between environmental, social and economic resources, and the type of development and their levels of consumption and use). Other important concepts that have characterised the transition city experiments are the central role of visioning (and a positive approach to changes and goals), social inclusion, and the capacity for awareness-raising and psychological insight.
In addition to the measures aimed at reducing emissions, at sustainable mobility (and others directed more towards environmental sustainability), there are:

– actions aimed at part of the community 'taking back' areas and regions or their living environment;

- integration and social inclusion measures;
- measures related to food supply chains and measures related to community living and environments on a human scale.

Participation is not only focused or concentrated on constructing the vision and strategic objectives, but it is the town as a whole that is the agent and party that implements the strategies for achieving shared goals and objectives.

Newman proposes, in the construction of strategies and measures for the resilient city, a number of evocative definitions or concepts evoked with reference to the city: Renewable Energy City, Carbon Neutral City, Distributed Dity, Photosynthetic City, Eco-Efficient City, Place-Based City, Sustainable Transport City. These key strategies contain, a number of principles deriving from the disciplinary debate on 'sustainable cities' (such as densification, sustainable mobility, and so on) and a number of strategies deriving from more engineering-based disciplines (such as the use of sustainable water management systems (LCD) and/or solutions for increasing energy efficiency).

4.3 CITY MODEL

This texts in this group, precisely because it includes various authors with a planning background, set out the structure or definition of urban systems (and their components), and planning actions explicitly related to the urban form. A general objective shared by these authors is the development of an action plans to make in the neighbourhoods, community or region more environmentally and economically healthy, habitable and resilient.

This group of authors (such as Coyle, Newman, Beatley and Boyer, for example), by greatly simplifying the models devised in the texts, separate out the built environment and other issues connected with networks or 'supporting systems'.

For example, Coyle proposes a model of the city (or urban system) consisting of the built environment and supporting systems. The built environment consists of the physical structures and organisation patterns of buildings, blocks, neighbourhoods, villages, towns, cities and regions. The supporting systems are: Transportation, Energy, Water, Natural environment, Food production, Agriculture, Solid waste, Economics.

A number of experiences with resilient cities (http://sustainablecitiescollective.com/) and experiments in urban transformation (http://www.resilientcity.org/) can be attributed to this group of authors.

5 RESILIENCE AND RISK

In the most innovative research and best practices aimed at the mitigation of territorial risks, the concept of resilience has assumed a central role in the construction of strategies that include within the objectives of reducing risks and hazards a plurality of goals aimed at territorial quality[8].

The concept of resilience in territorial risk management has now been established, certainly in scientific debate, for at least 15 years. Since that the topic of resilience has long been debated, there are also significant theoretical focal points in terms of interpretation, such as the relationship between resilience and vulnerability. As underlined Pelling *the idea of resiliency suggest a proactive stance towards risks. It has been discussed within ecological theory, system analysis and disaster studies* (Pelling 2003 p.7)

[8] See, for example, the many contributions relating to the research project on the sustainable development of the U.S. territories bordering the Gulf of Mexico, presented at the Venice Biennale, collected in the work by Eugenie L. Birch and Susan M. Wachter, Eds, 2006: Rebuilding Urban Places After Disaster: Lessons from Hurricane Katrina, University of Pennsylvania Press, Philadelphia; the best practices and researches devised by Pelling on the resilience of cities and urban systems, etc.).

	Conventional / High-carbon (CHC) community	Resilient low carbon (RLC) built environment
Urbanisation or development pattern	Dispersed uncontained growth Predominately auto-oriented urbanisation lacking clearly defined boundaries between the built and natural environment	Compact and bounded
Circulation pattern	Automobile oriented	Connected and multi - use
Land use patterns	Use-based zoning Control of uses with minimal power over the forms or sequence of urbanisation High density apartment sites abutting strip commercial development separated from single family subdivision by a multilane arterial	Form based zoning (as Flexibility in use)
Public space scale and form	Road way oriented, Public streets are scaled for automobile convenience, Little spatial enclosure for the public space, Parks and public space scaled to adjoining arterial or regional thoroughfares	Pedestrian scale and form, Multifunctional and connected
Building and landscape scale and form	Road way oriented	Pedestrian scale and form
	Conventional / High-carbon (CHC) community	**Resilient low carbon (RLC) built environment**
Transportation	Use of motor vehicles	Public transport, low/no carbon fuels and vehicles transportations demand-management technologies. Pedestrian cycling network
Energy	Conventional energy fossil fuel – generated	Renewable ad limited fossil fuel-generated electric power, improve the efficiency and the reduction of demand
Water	Conventional water supply system deliver water (potable and non – potable) via engineered hydrologic and hydraulic components Ron off and drainage based on conventional watershed or drainage basin management	Reduce the water demand, increasing the efficiency of performance of infrastructures, the storm water collection and discharge at local level (building, park, street..), the resilient storm water system at regional level Biological and recycling technologies for the waste water
Natural environment	The expansion of human activities into the natural environment ha reduced, fragmented ad isolated water habitats and other natural habitats	Improvement of natural habitats and biodiversity
Food production agriculture	Conventional food production consists largely of monolithic crop production (on petroleum-based fertilizer and other technological advances); conventional livestock production consumes 70% of all land used for agriculture worldwide, generates 18% of the world's greenhouse gas emissions	Sustainable agriculture and a regional supply food management
Solid waste	A minimal waste recycling or reduction The land filling and other high impact waste final destination	Sustainable solid waste system, recycling, zero waste approach (the production of products, the distribution, the recycling in use, the
Economic	The economic system focuses on increasing community prosperity by increasing the production distribution and consumption of good and services	Increasing the community prosperity through the production, distribution and consumption of goods and services that minimise or eliminate waste and non renewables

Tab. 1 Differences between Conventional/High-carbon (CHC) community and resilient low carbon (RLC) built environment (Coyle)

The concept of resilience was initially associated with (and opposed to) the concept of vulnerability: resilience was employed as the opposite of vulnerability and resilience strategies were therefore aimed at reducing the vulnerability of systems with regard to territorial risks. Subsequently, in the context of the scientific debate, resilience was associated with a wider vision and not just related to the reduction of vulnerability. From this point of view, the approach to resilience includes dynamic aspects (increasing the resilience of a system over time including theories of adaptation, not only at the time of reaction to disasters), aspects of scale and management of complex systems (reduction of the causes and determinants

of hazards and phenomena that increase the severity of disastrous events), socio-economic aspects (including both organisational and social aspects) (White 2010).
The conceptualisation of resilience in academia has been fuzzy and contested, and some lucidity is needed to understand this relatively new theoretical construct in relation to water and spatial planning. In recent texts, the study of resilience, while related to the issue of territorial risks (clear configuration of the aim) includes more general objectives: a more resilient system with regard to territorial risks is and must be, in general, an urban-territorial system characterised by higher overall environmental and social quality.

5.1 CONCEPTS OF ECOSYSTEM RESILIENCE

The concept of resilience used by many authors is that of ecosystem resilience. Resilience is understood as the capacity and ability, after a disaster, to emerge from stalemate in a condition that is not necessarily the same as the initial pre-existing condition. The capacity of a region to be resilient largely depends on the organisation and relationships that existed before the event: the more flexible the system, the quicker will be recovery to normality from the perspective of improvement and awareness.
If a community chooses to go on living despite the risk, then growth must be directed towards creating resilient cities capable of responding to the effects of a disaster. This type of approach, namely being aware of and cooperating with nature and not against it, can simultaneously achieve the goals of conservation and exploitation of natural resources without reducing the opportunities for growth (Burby 1998).
The integrated use of appropriate management tools and regional planning is needed to achieve a vision of resilient cities, reducing the intensity of growth in hazardous areas: by reducing the need to distort and obstruct natural processes, we will be able to reduce both the economic the social costs of vulnerable cities.

5.2 STRATEGIES

In the construction of strategies for territorial resilience against risks, there are many concepts characteristic of ecosystem resilience that are used as key principles:

- The homeostasis principle: systems are maintained by feedbacks between component parts which signal changes and enable learning. Resilience enhanced when feedbacks are transmitted effectively
- The omnivory principle: external shocks are mitigated by diversifying resource requirement and their means of delivery. Failures to source or distribute a resource can then be compensated for by alternatives.
- The high flux principle. The faster the movement of responses through a system the more resources will be available at any given to help cope with perturbation.
- The flatness principle. Overly hierarchical systems are less flexible and hence less able to cope with surprise and adjust behaviour. Top-heavy system will be less resilient
- The buffering principle: a system which has a capacity in excess of its need can draw on this capacity in times of need, and so is more resilient.
- The redundancy principle: a degree of overlapping function in a system permits to system to change by allowing vital functions to continue while formerly redundant elements take on new function. (Pelling 2003, p. 8).

Other authors (as Watson and Adams 2011) identify *the agenda of resilient design* that can be expressed by three key principles: multiple scales of impact, collaborative design and innovation in design, technology, and policy.
These strategies/principles are also contained in official documents of many bodies (as NOOA, FEMA and ONU agencies) set up to protect populations against risks: for example, the Federal Emergency Management

Agency (FEMA) has identified checklists for resilient cities/regions (related to flood plain management) or the document from the National Science and Technology Council Committee (Grand Challenges for disaster Reduction 2005, report for the White House office for science and technology) which contains actions to be implemented Towards resilient systems.
The concepts common to different authors for a risk-resilient system are: diffusion and diversity (redundant and diverse city), the rapid responses properties (efficient and strong city), the redundancy circuit (feedback and smart city); the storage capacity and the scale/hierarchy connection (independent, collaborative and adaptable city).

5.3 CITY MODEL

In general, the structure of the urban and regional systems proposed by the authors of this family is derived from the established methodologies and models of risk analysis and management. The local systems are broken down into subsystems and components (analysis by component: social, environmental, etc.) and into the relational components that exist between the subsystems (relational analysis: interactions between subsystems).

6 INITIAL CONCLUSIONS

The table shows a summarized comparison from this initial analysis of the literature on cities and resilience. In particular, the main disciplinary backgrounds, the scales or spatial dimensions under consideration (neighborhoods, regions, cities, etc.), the models of urban systems and the main concepts of ecosystem resilience referred to in the texts are specified for each family.
With regard to the concepts used, we are proposing a schematic summary which attributes the key concepts used by the authors of the three families researched. The schematic highlights where the key concepts are innovative in the field of planning and urban design and where these concepts can be found in the literature or are already in use.
The most innovative aspects and concepts common to the three families are:

- A strong link between physical, social and organisational elements;
- Strong relevance of local community and relevance to the social aspects;
- Focus and role of ecosystem services;
- Strong innovation in terms of the process;
- Relevance of the concept of process dynamics (and therefore of flexibility with respect to the dynamism of processes).

With regard to the contributions offered by the different families, it is possible to propose few more reflections.
Resilience and sustainability proposes innovative principles and strategies in the field of socio-ecological systems management, but does not appear to be strongly focused on urban and planning issues. Important strategies could derive from this family and be applied to urban design.
With regard to *Resilience and adaptation* family, the Transition cities experiences are very interesting in terms of innovation in the policies process and in term of strategic contents. The other experiences and proposals of this family are more focussed on adaptation strategies. The *resilience and risk family* developed since a long time a wide debate on resilience strategies aiming to the risk mitigation. The resilience strategies / principles related to the risk mitigation are more easily understandable by the general public: this because the population involved is usually more sensible to the themes of risk mitigation and prevention, and is thus more open to the adoption of innovative approaches, such as resilience.

	Resilience and sustainability	Resilience and adaptation		Resilience and risks
Disciplinary backgrounds	Natural sciences, biology, ecology, economy and social and political sciences	Planning, architecture, natural science, sociology		Engineering, Building architecture, planning, social science
Resilience definition	R. as the capacity to lead to a continued existence by Incorporating change'	**Planner approach** No definition of R.	**Transition cities** R. as the ability of complex system to absorb the stress using adaptation strategies	R. as the capacity and ability, after a disaster, to emerge from stalemate in a condition that is not necessarily the same as the initial pre-existing condition
Research and experiences Focus (scales and places)	- Theoretical / theoretical modelling - Development of local communities and regional development - Management of natural resources (linked to development of local community / regional development)	- Models / strategies applied to city / urban and metropolitan - Development of neighbourhoods and local communities		- Regional Development - Urban contexts - Projects focused on specific phenomena
Cities model (components)	- Social-ecological systems - Urban areas is the result of the interaction of four system (that have the same relevance): metabolic flows, governance networks, social dynamics, built environment.	**Planner approach** Cities system composed by the build env. supported by the supporting systems (Transportation, Energy, Water, Natural environment, Food production, agriculture, Solid waste, Economic)	**Transition cities** Community process of changing (not structured models)	- Cities/regional models are based on traditional risk analysis methods - City component physical, social and organizational
Resilience concepts used as key strategies	- Feeding diversity for reorganization and renewal - Interconnection between temporal and spatial scales varying - Recognition of the slow variables - Compact strong feedback - Adaptability, flexibility and innovation - Knowledge and communities	**Planner approach** No strong relation between resilience concepts and the strategies developed	**Transition cities** - diversity - modularity - local based - feedback - small	- Buffering - Core protection - Diffusion - Rapid responses - Redundancy circuit - Storage capacity - Waste nutrient recovery self-help
Resilience strategies (innovation for planning)	- Life is full of surprises - *Learning to live with uncertainty and change* - ***Feeding diversity for reorganisation and renewal*** - Combining different types and systems of knowledge and create opportunities for self-organization - Adaptability, flexibility and innovation based on feedback - **Memory**	No innovation strictly related to the resilience Newman proposes, strategies related to: Renewable Energy City, Carbon Neutral City, Distributed Dity, Photosynthetic City, Eco-Efficient City, Place-Based City, Sustainable Transport City.	- Diversity (and creative redundancy) - Modularity (organisational networks / and governance) - Local-based - Small - Balance between environmental, social and economic resources, and the type of development and their levels of consumption and use	- Redundancy & diversity - Efficiency & Strong (with the capacity to withstand events/external attacks of various kinds) - Independency & connections (ability to mutually support one other) - Adaptability - ability to learn from experience - Collaboration(multiple opportunities and incentives)

Tab. 2 Families of authors and summary of topics and approaches

Within the context of local governance processes, the concept of resilience affords possibilities and opportunities:

– Certainly the concept of resilience in itself contains significant possibilities, especially in the construction of scenarios and visions shared with local communities from a positive and optimistic perspective (Hopkins, Pelling). Issues such as the protection of environmental and ecosystem performance or the prevention of local risks can be translated not only into guidelines for constraints and safeguards, but as active construction projects for resilient territorial systems and communities.

Fig. 2 Schematic summary: strategic concepts, belonging and sharing (The scheme highlights (darker colour) where the key concepts are innovative in the field of urban planning/design and where these concepts can be already found or are already in use in the urban planning/design literature).

– Integrating the concepts of resilience into forward thinking capabilities for plans and programmes. Many benefits are derived from the efficient functioning of ecosystems, and, therefore, considering the services and benefits that derive from ecosystems as an integral part of the system of services and functions of local systems.

The following are some of the key strategies for resilient regions and cities that seem to be more innovative.

(Diversity and) redundancy: A resilient world promotes diversity in all its aspects and biological, landscape, social and economic forms. Diversity is a major source in terms of the options for our future. Diversity is a concept/principle already integrated in the planning polices/strategies. At the same time, if diversity implies the differentiation into elements and components, redundancy implies multiplicity of functions. Redundancy can also be approached through the principles of subsidiarity, understood as the interrelationship and repetition of a number of decision-making mechanisms including at the local scale. A resilient world has institutions that include some redundancy in the institutional structures and a degree of overlap between public and private in respect of access to ownership.

Recognition of slow variables: A resilient world must have policies focused on controlling threshold-related variables. By focusing on the slow variables that give shape to social-ecological systems and on the thresholds that remain , we have a better ability to manage the resilience of the system.

Adaptability, flexibility and innovation: A resilient world places the focus on learning, experimentation and the development of local rules, and embraces changes. One approach to resilience is to encourage new developments and innovations. In general, we aim for solutions to avoid change rather than find innovative solutions that mutate or assist the changes.

Knowledge and communities: a resilient world fosters social networks and flexible leadership. The resilience of social-ecological systems is closely connected with people's capacity to respond jointly and effectively to changes and disturbances.

Interconnection between spatial scales and time variables (already developed in urban design/planning): the issue of interconnection between different spatial scales and dimensions of time is certainly complex, and widely discussed in the field of urban planning and design. Studies on complex systems, however, tell us that in a resilient system, not everything is interconnected and dependent. There are relatively independent parts. The notion of over-interconnection, especially at intermediate hierarchical levels of hierarchy implies that once one part suffers stress, this shock reverberates throughout the whole system.

Solid strong feedback (already developed in urban design/planning): The feedback processes allow us to perceive the thresholds before crossing them. A resilient world has strong feedback (but not too strong). In this case there are very many references to the flexibility of decision-making processes and construction plan processes (Steiner but a great many others).

Future developments

Research paths include the following stages:

- reading up on and comparing the experiments carried out with regard to the three approaches identified (and making a comparison in terms of how efficient and innovative the methods and tools proposed are);
- identifying genuinely innovative aspects of resilience (extending the analysis not only to the theoretical aspects but also to the proposed measures, instruments and methods of analysis and action);
- reading (and comparing/classifying) websites and platforms (including their role, functions, effectiveness)
- identifying strategies to be integrated into the planning and urban design processes;
- applying key strategies and key principles to urban design and planning cases and processes.

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