Integrating Resilience Concept and Urban Morphology. A contradictory merging attempt or a promising combination?

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edited by
G. Strappa, P. Carlotti, M. Ieva
with the collaboration of
F. D. De Rosa, A. Pusceddu

URBAN SUBSTRATA & CITY REGENERATION
Morphological legacies and design tools

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Integrating Resilience Concept and Urban Morphology. A contradictory merging attempt or a promising combination?

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Abstract

Today cities are particularly vulnerable to any kind of pressures. The increase in urban complexity requires a better understanding of physical urbanization, and parallelly a shift in how cities are linked to environmental dynamics. Tackling the urban complexity requires a socio-ecological system-view where cities appear living and dynamic systems, whose processes and structures are interacting over time at morphological, ecological and socio-cultural levels. These interdependencies can be handled by understanding the extent to which urban forms will be able to resist, adapt to or evolve under pressures and fulfil needs and functions either similar or different from their original ones. However, the explicit introduction of the element of change in the urban morphology field might contrast with the traditional image of built environment linked to order and rigidity. To this regard, resilience concept appears an interesting lens through which reading and understanding the changing urban-world.

The paper explores the combination of urban morphology and co-evolutionary resilience, considering urban form as a key factor in urban resilience. Dealing with some resilient-morphological aspects, the work discusses possible interdependencies between resilience theory and urban morphology and seeks to understand if "resilient urban form" represents a "property" of cities or rather an "end-point".

Introduction

Today there is no doubt to sustain that we live in an urban planet, where built environment surrounds and contains basically everything of what we do. More than 54% of world population currently lives in cities (UNDESA, 2014) and the percentage is projected to reach 67% by 2050 (UNDESA, 2014). This obvious and great acceleration of human footprint on earth in terms of people and activities, especially the most recent ones related to the use of resources, soil and energy, has moved humanity into a new proposed geological era called "Anthropocene", the age of man, characterized by deep influence of human activity on natural processes on Earth (Crutzen, 2002; Steffen et al., 2007; Folke, 2016).

Additionally, the unpredictability of the future cities is also related to environmental degradation, climate change and biodiversity loss, which in turn make them particularly vulnerable to any kind of pressures (Forgaci and Van Timmeren, 2014). Many evidences highlight that if from one side, industrialization and population growth are the main reasons for the increasing urban pressure and risk of economic, technogenic and terrorism crises; on the other, natural-related challenges are leading to the formation of new threats, which are particularly accelerated by climate change (Fischer, 2018). This condition leads also to re-think about guiding concepts as resilience, which is partly a relatively new approach in the urban global debate although a historically relevant principle for cities faced by changes.

Indeed in history, cities have proven to be remarkably resilient complex systems: many towns have existed for thousands of years and have persisted in the face of natural and human-induced disasters to become stronger and in some cases more resilient (Elmqvist et al., 2019). However, the global context of the Anthropocene is changing with a combination of rapidity and magnitude of unprecedented growth which does not allow for a spontaneous laissez-faire of our cities, especially under current environmental and climatic circumstances. Over the last 25-30 years, urban systems all over the world have undergone significant transformations associated with rapid urban migration, urban poverty, informality and resource scarcity, as well as new social, economic, political and environmental changes (Du Plessis et al., 2015). Thus, cities of the 21st century must be resilient to climate and ecosystem changes as well as to socio-economic and political pressures. But are there any physical properties already in place? And which resilient concepts can find translation in urban morphology?

Many scientists see urban form as a major factor in achieving resilience at urban level, being so directly involved in change over time. Strengthening urban resilience, and consequently the evolution and survival of cities, requires understanding how urban form can accommodate change and regeneration through incremental adaptation that leads to transformation of built environment too.

The critical point deepened in this work is to understand how the tensions introduced by the element of slow-change in cities, can be handled through the combination of urban form and co-evolutionary resilience approach (Forgaci and Van Timmeren, 2014; Marcus and Colding, 2014) and through which properties. Indeed, although several studies have recently tried to introduce the element of change in urban form dimension, an explicit morphological understanding of resilience concept related to slow-variables affecting cities is still lacking in scientific research. The paper focuses then on this recent merging attempt and deals with some morphological features which might facilitate resilience at physical level, might provide proper quality levels in the daily urban life, and might become a central task in managing both historical and new cities affected by transformation.

Theory of complexity in the urban framework

The increasing challenges faced by our cities all over the world highlight the fact that they change. In this sense, it is reasonable to argue that past approaches to study cities and urban change are inadequate today, as they base on modernist principles which consider the city as simple, static, ordered, predictable and understandable by breaking it down into basic units. However, as evidences show, this is far from realistic. When adopting a systemic view of the city, Holling and Goldberg (1971) sustain that urban systems are complex in strength of the relationship between their constituting elements. Thus, the focus on one single component and its individual performance does not provide the whole understanding on how the system might react, adapt and transform.

In this perspective, the complexity theory appears the best approach to understand the city as a complicated web of relations between different components of a unified whole (Capra, 1984). The reason of this view is simply related to the growing awareness that the Newtonian "world as machine" cannot work today in cities, where concepts of change, development, evolution and transformation prevail. This holistic understanding of urban contests as complex systems with uncountable interrelationships between objects is helpful to tackle complex phenomena like urban change. In this scenario, the urban system is more specifically considered as a complex adaptive system (CAS) in which several different agents interact with each other in a non-linear, cross-scalar, dynamic manner and follow rules of adaptation (Page, 2011). These systems are in constant state of "becoming", as they never reach a permanent state of equilibrium (de Roo, 2010, 2012).

This recent approach of considering cities as complex and dynamic systems has led to the idea of "socio-ecological systems" where people and nature are interdependent networks (Folke et al., 2010; Davoudi et al., 2013). Socio-ecological systems should not be intended as "social systems plus ecological systems" (Norberg and Cumming, 2008). Instead, they should be viewed as integrated entities, whose processes and structures interact over time at morphological, ecological and socio-cultural levels. In this perspective, the purpose here is to shed some lights in the field of urban morphology and establish which properties of urban forms make cities more connected with the element of change and the increasing urban-challenges happening over a long time period.

Resilient concept in urban contest

Within this contest, resilience has been presented as a useful approach to understand and manage cities and urban-complexity-growth in unpredictable times. Du Plessis (2008) argues that a SES perspective, and by similarities a CAS-one, should be adopted when approaching the study of cities and resilience. This is related to the fact that cities behave as complex adaptive systems, as well as social-ecological ones, performing non-linear, self-organising and diverse networks. This allows us to associate urban form with complex adaptive systems and to read it through the lens of resilience, as an important character of adaptive systems like cities. And to this regard, the evolutionary interpretation of resilience, so called "evolutionary resilience", seems particularly appropriate. Generally, evolutionary resilience can be defined as the capacity of complex socio-ecological systems to change, adapt or transform in face of strains and stresses, rather than facing change with a "return to normality and previous state" (Carpenter et al., 2005; Simmie and Martin, 2010; Davoudi, 2012). Therefore, this ability allows urban systems to survive and thrive in the face of uncertainty, adversity and change, re-defining themselves by innovation (Sharifi, 2018a). The theoretical idea behind is that a resilient system is capable to "bounce forward" to its original state when change occurs, while retaining essentially the same function, structure, identity and feedbacks (Walker et al., 2004). Using the comprehensive model to describe dynamic processes of complex adaptive systems, proposed by Holling and Gunderson (2002) and called "Panarchy Model of Adaptive Cycle", the focus is on the dynamic relationship between adaptability, transformability and stability. This acceptation acknowledges that systems are constantly undergoing change and that there is no one single trajectory to follow nor final status to reach.

However, because of a recent overuse of the term in several polices, international strategies, urban assessments and urban agendas, there is still no mutual consensus on what evolutionary resilience means in urban and practical terms (Davoudi et al., 2012). The combination of resilience and urban form raises the question of "which features of urban form enable or discourage change to take place". This step in central to understand if resilience in space is merely a goal to pursue in the generation of long-term and high-quality spaces, or rather a means for quality of urban space and life inside it.

Merging resilience and urban form

The passages explained until now evidence the need to understand the links between urban morphology and resilience, not only in terms of spatial measures capable to support social-ecological systems but specifically resilient social-ecological systems. However, as previously highlighted, the integration is not immediate as the physical form of cities may be considered un-changeable and rigid. Viewed in that way, resilient urban form might appear an oxymoron. This is related to the traditional image of physical elements as inflexible, rigid and, apparently, in critical contradiction with the major resilience features of flexibility and adaptability.

Nevertheless, when thinking about the city-reaction to different types of shocks, stressors and variables, it is inevitable that design and urban form elements can constantly get transformed, or at least influenced, to enable the urban system to adapt to changing conditions. Sharifi (2019) argues that a "resilient urban form" includes qualities that optimize the capacity of the urban system to continuously maintain proper levels of performance under constantly changing circumstances. This integration defines the degree to which urban systems maintain integrity and functionality, considering the interconnected networks of spatial and socio-ecological systems through different spatial and temporal dynamics, in permanent changing state. To Marcus and Colding (2014), few attempts have been made to link urban sciences to the adaptive renewal cycle proposed by Holling, but it is worth considering them as a relevant voice within this exercise. Indeed, same conditions of non-linearity, discontinuity and thresholds in ecological systems can be applied to urban ones. When considering the city not as a homogeneous structure but rather "a spatial mosaic" (Holling and Goldberg, 1971) it is logical to identify resilient-system properties that may favour (or rather, have already favoured) spatial evolution over time. Moreover, analysis of living and evolving cities highlights evident "forces" mainly derived from historical layering over millennia, which follow long-range time order, spontaneity and correlations that allow both change and diversity in the urban system (Salat et al., 2014).

View in that way, the concepts here introduced in urban morphology refer not only to the form of human settlements, but also to the process of their formation and transformation over time (Chen, 2014; Pajouh and Alipouri, 2019). Thus, urban form can be seen as the spatial representation of a complex and dynamic combination of interactions between multiple social, economic, geographical, cultural, physical and technological factors that play a defining role in the dimensions of materials and immaterial. One may state that urban form and morphology base on a double level of analysis: the spatial level and the systemic level, which is less perceptible than the first but indeed very dynamic and active. As a consequence, steps in recognizing the dynamics of urban morphology can be central to understand design properties and their role in enhancing the resilience of such a complex system. However, as previously explained, resilience of urban form is influenced by so many tempo-spatial dynamics occurring among different scales and elements. Therefore, it becomes important for this work to set some theoretical boundaries among the following key questions: "resilient urban forms to what?" and "resilient urban forms for what purpose?".

This clarification makes the merging attempt of "resilience theory" (Holling, and Gunderson, 2002; Davoudi et al., 2012; Folke, 2016) and "spatial morphology" more research-oriented and tangible. Unquestionably, it represents an important step in the emerging field of translating resilience theories into variables of spatial forms, and in making the findings informative and supportive in spatial planning theory. Hence, before identifying some morphological properties of resilience, it is essential to clearly address the above inputs.

Resilience to what? Resilient urban forms in face of which disturbs?

As evident from the previous sections, evolutionary resilience is a growing discourse under the wider urban-sustainability umbrella, which undertakes that resilient principles constitute a promising theoretical "toolbox" to understand complex-adaptive systems and enhance quality of life in cities (Marcus and Colding, 2014; Samuelsson et al., 2019).

However, in this complicated-contest it is necessary to focus on some specific stressors and discount others, as it becomes clear that being resilient to everything is a challenging task. In line with Davoudi et al. (2012), the definition of a system's boundary inevitably focuses on some things and discount others. Parallelly, we believe that within the spatial field, considering the general type of resilience (Walker & Salt, 2012) risk to create a contrast between methods to face disturbs and stressors, and thus to produce very different resilient properties of urban form not related to each other. Consequently, this bounded approach leads to the choice of focusing on slow variables affecting cities, rather than abrupt changes. This means to exclude from the analysis, for instance, several sudden variations like climatic shocks, natural extreme events, man-made disasters and so on. Furthermore, this implies to avoid "resilient design strategies and solutions" sometimes already in place at building and neighbourhood level where purely engineering and technological solutions, albeit effective and performative, concur in enhancing resilience.

On the contrary, slow variables do not follow a fixed timescale, but their movement underlies the system horizontally and for undefined-long term. They might relate to both man-made and natural movements affecting cities as, respectively, urbanization (which implies more housing, services, infrastructures, etc., for more people) and natural phenomenon as sea level rise, erosion, … (which increase the conflict between city and nature, recently also accelerated by climate change). Because of their slow and external-driven nature, they can somehow be considered "controllable" and then closer to the reorganization of system-dynamics (Walker et al., 2012). The spatial operationalization of these processes has an immediate link also with the second question, which aims to define the system functions to be strengthened when translating the resilience paradigm.

Resilience for what? In the purpose of which function (s)?

Adopting the co-evolutionary approach of resilience to urban form has an influence also on system purposes. Indeed, rather than viewing slow and inevitable variables as problematic, the built-environment affected adapts and constantly reinvents to innovate the system while maintaining basic functions and structures (Holling, 1987, 2001; Davoudi et al., 2012). In this discourse, it is central also to understand how different urban form features may pursue distinctive resilience levels. Therefore, when identifying the functions for which the urban form should be resilient for, we assume that the prime goal is to ensure the quality of the urban environment in the day-to-day life. In this sense, the urban system addresses directly to those properties which may spatially facilitate citizens-life, not just for survival, but mainly to create a tangible and intangible sense of place (Ståhle et al., 2005), identity and healthy. This introduces an approach to urban form that through the material dimension crystallizes and represents history, culture and transformation processes and, over time, builds up the sense of place, community and security which contribute positively to the quality of life in cities (Chen, 2014).

Resilient properties of urban form

Once clarified the resilience-interpretation here adopted, the paper turns to its spatial translation as a layered concept consisting of some spatial features capable to consider the key characters of slow-variables and quality of the urban environment in the day-to-day life. In the following paragraphs then, resilience of urban forms is explained through some space-based attributes linkable to co-evolutionary theory of resilience selected from an updated literature review over 30 attributes related to resilience across different scales and facing different pressures. Since the selection-process is still ongoing and the current analysis does not pretend to identify all the spatial components of the bounded framework described, in this phase the scale-issue is taken into account but without focusing on a specific spatial level. When recognizing the complex and nested network of hierarchical scales characterizing urban systems, it is evident that each scale might have its own resilient-spatial properties. However, these issues need further investigation and more detailed analysis. Thus, this study maintains a comprehensive perspective where the spatial features provided can be linked to a general level of urban form.

Starting then from a broader collection and from the purpose of this study, the resilient form of cities is explored with eight properties, considered as the most appropriate "translators" to introduce resilience in urban form, while remaining in the overmentioned boundaries. Table 1 provides an overview of these properties and a brief explanation of each.

Table 1 - Resilient properties for Urban Form (Source: Author's elaboration from literature review, 2020)

Resilient Properties of Urban Morphology	Description
Redundancy	In the urban-changing contest, redundancy allows systems to continue to function when subsystems fail. If one part collapses, another one can take its place while performing the same functions (Fleischhauer, 2008). To Feliciotti et al. (2018), redundancy is the disposal of multiple components or pathways, which provide an insurance mechanism for anticipating change, damage or failure. A redundant system shows high availability of substitutes and thus lower likelihood to stall in case of failure (Anderies, 2014). Therefore, redundancy is a structural property of the urban form autonomous from any specific future scenario (Lhomme et al., 2013), which can help the survival of the system and its effective functioning, when both unexpected shocks and slow variations occur.
Modularity and Reproducibility	Following the theory of redundancy, "modules" favour the distribution of functions or services in a system, so that their localization is spread across decentralized sub-systems (Ahern, 2011). It seems that they work in parallel: internally, modules are joint by robust close-range internal connections while externally, they are tied by relatively weak long-range connections (Salingaros, 2000). Thus, modularity provides a system with different functional modules that can evolve and reproduce somewhat independently without affecting the others and can promote transformation and adaptation to slow changes (partly as to unexpected ones). Modularity enables basic functions and structures to aggregate and to form new higher scale combinations while maintaining their individual identity (Salingaros, 2000). In the contest of resilient urban form, modularity affects interaction between urban elements and across different scales.
Efficiency of scale-systems at scale-level	Applying the concept of efficiency in resilience, even if mentioned in literature, is controversial. Several authors claim that efficiency is achieved at the expenses of other properties as diversity (Anderies, 2014), connectivity, redundancy and modularity (Novotny et al., 2010), in a way that decreases overall resilience and simplifies problems through processes-optimization.

	However, in complex systems theory, efficiency does not imply a process of simplification but, on the contrary, it requires an increase in structural complexity at every scale (Salat and Bourdic, 2012). According to Feliciotti et al. (2016), in the urban form field, efficiency relates to the hierarchic organization of different urban elements and needs that, at all scales, the same level of complexity is guaranteed.
Diversity in agents	Even though diversity is sometimes used as a synonym of "mixed land uses", they are actually quite different in terms of spatial morphology. Indeed, diversity is "a multidimensional phenomenon" (Turner et al., 2001) that encourages further desirable urban properties, including more variety of housing types, household sizes, building densities, community - ages, cultures, and incomes (Jabareen, 2006). On the contrary, "mixed-land-use" indicates the variety of functional land uses as residential, industrial, agricultural, commercial, and so on, and is thus mainly related to the zoning activity of urban planning. Therefore, it is evident that diversity represents the social and cultural context of the urban form. In this sense, we must also recognize that beyond the general knowledge about city performance and zoning activity, there are specific factors which make each place unique. It has also strong connections with the creation of multiple spaces and places (Ståhle et al., 2005; Marcus and Colding, 2011), which can favour and develop new levels of urban-settings, characters and identities. In Samuelsson et al. (2019), diversity is a conditioning attribute to build resilience in systems characterized by complexity.
Flexibility and adaptability of urban structure	New urban conditions faced by "slow-phenomena" related to climate change are very likely to cause more unstable conditions in many cities of the world and with different direct impacts. This means that several components of urban morphology as housing, vegetation and land need to be designed with progressive attention for slow changing circumstances as increased water flows, thermal conditions (indoor and outdoor), harsh winds, and so on. These pressures, taken together with future growths in population, lead to the need for cities to withstand change of forms and functions. Practically speaking, it is, for example, a matter of ground floors of buildings and of higher floors high enough to enable different types of use and functions. A small-scale property classification and diversity of buildings creates a mix of uses and technical solutions which provide the conditions for

	flexibility of space over time as well as for good levels of urban-life (Stangl, 2018). Additionally, when linking this property to the spatial dimension of many layered cities, it can represent an opportunity for the most affected areas to add new quality, becoming more complex and creative (Salat et al., 2014).
Density	Density is a dominant feature in both sustainable and resilient discussions on urban forms. Generally, it refers to the ratio of people, dwelling units, bed unites or habitable rooms to land area (hectare). Density and dwelling type affect urban sustainability through different levels of energy consumption, materials, land for housing, transportation, and urban infrastructure (Walker and Rees, 1997). To IPCC 2014, urban density affects GHG emissions however, it can be considered as a necessary but not sufficient condition for low-carbon cities (Revi et al, 2014). In UN-Habitat perspective, working on urban density means to intensify the density of existing built-up areas through infill development and setting growth limits (UNDESA, 2014). Following our resilience perspective, density deals with urban issues affecting the built environment. Indeed, making density a key-variable of resilient space leads to estimate realistic land requirements over a 30-year period and to encourage social interaction. Working on density then means to develop two parallel paths: non-physical processes and functions in place, and connected spatial patterns.
Compactness and Proximity of functions	In tight relation with density, compactness refers to urban contiguity (and connectivity). Sharifi (2019) indicates compactness as an indicator related to the clustering degree and capable to understand if a city follows monocentric, polycentric or other patterns. In the light of future urban development, this property should be developed adjacent to existing urban structures (Wheeler, 2004). Parallelly, when referring to existing urban fabric, the concept is linked also to the containment of further sprawl and not only to the reduction of the already present one (Hagan, 2000). Thus, the feature can enhance proximity, synergy and effectiveness of functions, improving the quality of urban space. Additionally, indicators based on clustering as compactness are directly linked to other popular urban forms, such as centrality and accessibility, which can be developed in future steps of this research.

Connectivity	In Feliciotti et al.'s perspective (2016), connectivity represents the "ease of flow" within a system and across systems. However, when introducing this physical property in resilience discourse, there is no a uniform interpretation: on one side, with high connectivity both knowledge diffusion and recovery after pressure are favoured in urban contests; while on the other, with low connectivity disturbs-expansion is contained and thus the conservation of "pockets of memory" at physical level is enhanced (Marcus and Colding, 2014). At spatial level, there is a need to balance over-connection and fragmentation within forms and, even more required, it is important to understand if connectivity is able to guarantee resilience in response to specific disturbs (Resilient to what?).

Discussion

The overmentioned outline is far from complete, neither can be considered definitive. However, it provides an overview of the key morphological features that, in response to specific questions (Resilience of what? And for what?), may translate resilience into spatial level. This means also that, rather than an end-point, resilience can be referred to as a context-sensitive property of urban form, whose characteristics may vary according to several factors linked to tempo-spatial dynamics, risk to face (R to what?) and purpose(s) to achieve (R for what?) (Sharifi, 2018). Indeed, as previously clarified, in urban complex systems there are several levels which operate across multiple scales. Consequently, these resilient spatial characters can be recognized also depending on the scale of investigation and on the organization of spatial elements.

Following the idea to maintain a comprehensive categorization to read the urban structure, a visual metaphor is here proposed. In relation to the previous features, it seems that a red thread connects them all. This common line is represented with the image of a leaf which can enhance the capacity of urban complex systems to adapt and transform to changes (Salat and Bourdic, 2012), (Figure 1). Indeed, there is reason to state that representing the city structure as a leaf is an interesting method to translate resilience concept at spatial level. In morphological terms, leaves are totally connected among intermediary scales, from the highest branches to the finest capillaries. Furthermore, their structure presents high degrees of complexity on all scale-levels, resembling then to many other complex-systems as living organisms, ecosystems, economic systems, and so on. The leaf-system of veins, connections to one another, repetition of connections and distributions, makes the urban structure much stronger for facing slow variables and for reorganizing basic functions.

The overmentioned properties of resilient urban forms are connected with the leaf structure also because features like hierarchy of scales, redundancy and modularity are present in leaves, in parallel with flexibility of space and functions, levels of diversity and self-organization.

Figure 1. Representing a city as a leaf (Source: Authors elaboration, 2020)

A deeper focus on the leaf structure can for instance demonstrate that within its series of connections and densities, there is a certain intensity and redundancy that can influence the system-reaction to change. Physical properties of a city (and of a leaf too) can for instance prevent dangerous fluctuations from spreading quickly through the system, dissembling it and enabling transformative capacity. Rather than a tree, many cities resemble mainly to a leaf also because within this structure, variables-flows are managed more organically and spontaneously than in a tree structure, where efficient distribution tends to allocate stationary flows through main branches, in the most efficient way. On the contrary, the leaf-model guarantees that if a vein is interrupted or compromised, the redundancy of the system will allow the flow to get around the obstacle via secondary paths, so to keep on reproduction and evolution, while maintaining basic functions and structures.

Recognizing that a more detailed explanation about the functioning of a leaf-city and of each property can be analysed at deeper scale-level, it should be noted that the whole resilient framework presented for morphology is also able to respond to the two overmentioned questions. Broadly speaking, in "Resilience to what?", the eight urban form measures may improve resilience in response to slow variables. For instance, redundancy may provide multiple socio-economic and environmental components which favour a mechanism for anticipating slow change, possible damage or thresholds. As a structural component, redundancy ensures the survival of the system and contributes to maintain the effective functioning of life-quality elements. Density is another urban characteristic frequently mentioned as it favours adaptation and transformation of built-environment, through realistic estimations of land requirement over a long-time period. Turning then to the question of "Resilience for what?", the selected properties are capable to generate form-configurations addressing quality of daily-life in the city. In this sense, diversity may develop functional options addressing spatial evolution through time. Indeed, the formation of multiple spaces can favour the production and reproduction of social and spatial situations, ensuring the city's quality (Berkes et al., 2003; Marcus and Colding, 2011). Reproducibility and modularity as well make a system more resilient, promoting spatial-independent evolution of functions, persistence and adaptability.

Conclusion

In this paper, we present a description focused on the physical dimension of urban space as an element of a more complex system. The properties above are far from exhaustive, but this aspect is not a weakness of the work but rather a broader opportunity to examine more in the future steps. Three main comments may close this investigation.

Firstly, the overmentioned features open the possibility to spatially recognize resilience in urban built environment, linking these elements to design dimension. This is a crucial step because it enables the critical passage of resilience from theory to practices, highlighting the need to progressively connect science and practice.

Secondly, the generic approach adopted to describe resilient-spatial properties favours its easy application to different spatial scales. This means that the characteristics identified can be translated in different levels of urban systems, passing for instance from the whole city-scale to the neighbourhood-one.

And thirdly, the properties remind that despite urban form is the most concrete dimension of cities, as Marcus and Colding state, "it does not exist in isolation" (2011). Indeed, morphology exists within a more complex network of tangible and intangible elements which have developed through time and have made that place "typical of something". This aspect makes the property-selection particularly delicate and more challenging than other urban dimensions.

Therefore, further research is needed to deepen these aspects and better explore how resilience can be recognized as an underlying property of space. Recognizing resilience as an urban-design aspect can definitely get out from umbrella-discourses on resilience, by firstly distinguishing end-points from means of urban transformation-processes. Additionally, translating resilience in practical terms of morphology can also lead to discern it from sustainability concept, which has created several overlaps and misunderstandings in the discussion for a long time.

Thus, there is reason to believe that these steps can represent a contribution in the urban morphology field, especially under the current scenarios of increasing uncertainty. Furthermore, introducing theories of resilience in urban-form-understanding might facilitate the regeneration of some contests affected by change. Finally, these resilient morphological elements prove that integrating Resilience Concept and Urban Morphology is far from contradictory: the combination is promising, especially for those cities experiencing extensive processes of transformation.

Illustrations and tables

Table 1 - Resilient properties for Urban Form (Source: Author's elaboration from literature review, 2020)

Fig.1 - Representing a city as a leaf (Source: Authors elaboration, 2020)

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