Resilient urban planning: Major principles and criteria

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Abstract

The notion of resilience is rapidly gaining ground in the urban sustainability literature. The frequency of recent incidents including natural disasters such as earthquakes, tsunamis, and hurricanes, and also difficulties caused by the economic downturn has highlighted the vulnerability of human settlements and makes the appropriate consideration of resilience in the planning for future of urban areas of vital significance. Development of an assessment framework for evaluating the extent of resiliency of urban areas can be an effective way of incorporating resiliency-related issues into the urban planning process. For this purpose, it is necessary to clarify the implications of the resilience concept for the sustainability of urban areas. It is also important to identify resilience-related principles and criteria that should be embedded in the framework for assessing the resiliency of urban environments. This study involves an initial review of the literature on resilience and urban sustainability to extract a comprehensive set of criteria that can be used to develop an urban resilience assessment system. Moreover, it tries to design a conceptual framework, illustrative of the inter-relations between these various set of criteria. Criteria for assessment of the resilience of urban areas are divided into several main themes that cover environmental, economic, social, and institutional dimensions of sustainability. These themes would further be broken down into major criteria to account for important relevant areas such as land use, infrastructure, health, etc.

The output of this study can be used as the basis for defining a set of precise indicators that will constitute a potential assessment tool for measuring the resilience of urban developments. The resilient assessment process has the capacity to provide decision makers with a clear and comprehensive picture of the resilience of the development proposal and supports them in making better informed decisions.

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1. Introduction

Since the publication of the Fourth Assessment Report of the International Panel on Climate Change (IPCC) [1], which provided evidence that climate change is already occurring, there has been a noticeable shift in the rhetoric about climate change, moving from mitigation only to mitigation and adaptation strategies [2]. Scientific community and policymakers are now coming to realize that adaptation measures should be considered as critically important in addressing the impacts of continuing climate change. While climate change is a global issue that affects various human settlements, the impacts are expected to be more severe in cities. This is because the majority of world population is now living in cities and population projections show that roughly all future population growth will occur in urban areas. Ironically, many of these urban areas are located in places that are prone to a wide array of natural and man-made disasters [3].

Climate change is not the only phenomenon threatening the short and long-term sustainability of urban areas. Among others, managerial mistakes [4], recurring economic crisis, and terrorism [5] are some agents that cause disturbance in the urban system. Addressing this wide range of threats requires having appropriate knowledge of the main parameters influencing the mitigation and adaptation practices in cities. An integrated framework composed of various resilience related criteria can assist urban planners and decision makers in their efforts to identify areas that need work and improvement [6]. Furthermore,
having a set of criteria at hand, could be regarded as a good effort towards simplifying resilience as a complex issue and making it more understandable to various stakeholders in the society [7].

Understanding this need, the major purpose of this paper is to identify key criteria of urban resilience that can be used as a starting point for developing a more integrated framework for assessment and improvement of the resiliency of urban areas.

The methodology used in this study is described in the next section. Section three outlines the theoretical underpinning behind urban resilience and provides a brief overview of previous work on developing criteria and indicators for assessment of urban resilience. Section four presents some of the main criteria that can be utilized for assessment of resiliency. The paper concludes by highlighting the main findings of the study and identifying the next steps that should be taken.

2. Study design

This paper reports on the initial stages of development of an integrated framework for assessment of urban resilience. An eclectic literature review is conducted to identify criteria and indicators which are associated with resilience of cities. Not only literature on adaptive and mitigative aspects related to climate change is reviewed, but also documents addressing other pertinent subjects such as security, management, and economic crisis are analyzed. Literature from various types of disciplines has been reviewed for the purpose of this study. A preliminary search was conducted in the Scopus, Web of Science, and PubMed to find academic papers with a combination of “resilien*” and any of the following terms in their titles, abstracts and keywords: urban, city, community, building, climate change, adaptation, mitigation, assessment, planning, criteria, indicator. After gaining access to the target publications, we started analyzing their contents to distill resilience related criteria. The references section of each publication is also reviewed to find other potentially related publications and add the relevant ones to the database.

Until this stage, a total number of 332 publications, including research articles, review articles, book chapters, and books have been acquired. This article draws on insights from 43 papers and therefore is far from being complete.

3. Resilience and past research on development of tools for its assessment

The concept of resilience has traditionally been used in physics and psychology to respectively indicate the ability of an object to return to its original position after receiving a hit and the ability to successfully survive a shock or trauma [8]. It was first introduced into ecology in 1973 by Holling who described it as a measure of the ability of systems to absorb change and disturbance without losing the pre-disturbance relationships between their constituent elements [8, 9]. Despite the abundance of research on resilience, there is still no single, universally accepted definition for it. Likewise sustainability, resilience is a normative concept which is not easy to be presented in quantitative terms [10]. However, there is a broad consensus in the research community that city as a dynamic entity is not only an ecological system but also a social one [11]. As a dynamic, socio-ecological system a city is undergoing a constant process of change and adaptation. This implies that resilience in urban areas should be considered as an adaptive process which does not necessarily require the system to return to an equilibrium state after having been hit [2, 8]. Arguing that time scale is an important dimension of resilience, Engle, Bremond [12] describe resilience as a system’s ability of short-term coping and long-term adaptation. A community should be able to absorb impacts in the short term and self-organize and increase its capacity for learning in the long run [11, 13].

Relatively little research exists on the development of tools for assessment of urban resilience. Historically there has been more focus on issues such as sustainability and a variety of tools are available to assess sustainability at different scales [14, 15]. It might be argued that sustainability criteria can be used as a proxy for assessment of resilience. However, this is not always true. Fleischhauer [5] introduced several indicators that can be used to assess the resilience of spatial planning. Frazier, Thompson [6] conducted a study to develop a set of place-specific indicators for assessment of baseline resilience in Sarasota County, Florida. They argued that various indicators should be weighed differently. There is still no research collating various resilience related criteria into one assessment framework. This is the gap that
this research tries to fill. In the next section some of the main criteria distilled until this stage of this research are presented.

Table 1. Some of the major criteria that can be used in a framework for assessment of urban resiliency

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-theme</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>Water</td>
<td>Permeable pavement and bioswales, urban tree canopy, water demand and consumption, water efficient landscaping, protection of water-sensitive lands (wetlands, etc.), water demand and conservation systems, water quantity and quality monitoring, high-efficiency irrigation</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>Energy demand and consumption, flexibility of grid, urban energy supply systems for increasing shares of renewable energy, reduce end use energy demand, energy monitoring</td>
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<tr>
<td>Spatial configuration</td>
<td>Street connectivity, pedestrian route connectivity, walking trails that link with public transportation routes, accessible connection to evacuation routes, placing interdependent infrastructure close to each other, infrastructure redundancy, urban form (compact, dispersed, poly-centric), density of buildings, independent infrastructure, urban size, elevation, mixed-use development, variability and spatial heterogeneity, avoiding flood plains,</td>
<td></td>
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<tr>
<td>and location</td>
<td>Transportation</td>
<td>High frequency schedule public transportation, principle arterial miles per square mile, vehicle ownership,</td>
</tr>
<tr>
<td>Green infrastructure</td>
<td>Parks, forest conservation, waste management,</td>
<td></td>
</tr>
<tr>
<td>Defense structures</td>
<td>Coastal defense structures (dykes, levees, dunes, etc.)</td>
<td></td>
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<tr>
<td>Sheltering</td>
<td>provision of open space for shelter, percent vacant rental units, number of hotels/motels per square mile, evacuation routes,</td>
<td></td>
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<tr>
<td>Building and design</td>
<td>Building insulation, building layout and orientation, reducing air infiltration and thermal bridging, natural ventilation, preservation of housing, building codes, housing age,</td>
<td></td>
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<tr>
<td>Technology and</td>
<td>Generating and making use of information, geospatial information and communication technology, volunteered geographic information, innovation, data availability, visualization technologies, alerts and emergency notification systems, embracing e-commerce</td>
<td></td>
</tr>
<tr>
<td>information</td>
<td>Security</td>
<td>Defensible spaces, visibility of security infrastructure, city-wide surveillance networks, biometric borders, surveillance cameras,</td>
</tr>
<tr>
<td>Environment</td>
<td>Ecosystem</td>
<td>Biodiversity, restoration of hydrologic flows, conservation of ecologically vulnerable areas, proximity of different habitats, erosion rates, total maximum daily load,</td>
</tr>
<tr>
<td>Economy</td>
<td>Self-sufficiency, urban agriculture, urban green commons (allotment gardens, etc.), structure of the budgetary system, financial support, financial stability and flexibility, insurance and compensation system, diversified livelihoods, product service systems, regional economic balance, taxation and fiscal policies, personal economic security, job diversity of residents, housing capital, employment, tourist attraction, business size, complementary currencies,</td>
<td></td>
</tr>
<tr>
<td>Institutions</td>
<td>Planning</td>
<td>Zoning regulations (intensity of development in hazard prone areas), subdivision requirements that take account of risks and vulnerabilities, human occupancy of hazard zones, hazard analysis and creation of hazard maps, control over unauthorized development, scenario-based planning, utilization of push and pull factors, collaborative planning, collective memory, proactive planning, level of flexibility, land and property acquisition,</td>
</tr>
<tr>
<td>Governance</td>
<td>Centralized government approach, carbon pricing, public participation, a certain degree of accountability and autonomy, interpersonal and interagency trust, inter-organizational cooperation, political stability, strength of the leadership, evacuation and emergency management drills, city networking at different levels (regional, national, transnational), transparency,</td>
<td></td>
</tr>
</tbody>
</table>
Social and demographics
Culture of cooperation, balanced demographic distribution, intergeneration ties, cultural diversity, social cohesion, self-organization, education, awareness level, rate of face-to-face interactions, poverty rate, social networks, income level, aging population, place attachment, language proficiency, religious bonds, human behavior,

Health
Responsive health systems, health coverage, health access,

4. Major resilience criteria

In order to save space, the major criteria related to urban resilience are shown in Table 1. As can be seen from the table, these criteria cover a wide variety of issues ranging from water and energy efficiency to social relations in the community. Evaluating the performance against these criteria would help planners and decision makers acquire a reasonable amount of knowledge about the community’s status with respect to resilience.

5. Discussion and conclusion

The main purpose of this study was to cull some major resilience related criteria that can be used for the development of an intergrated assessment framework. Presented results are from the preliminary stage of the research and far from being exhaustive. More resource should be reviewed to obtain a more comprehensive list. Relevance of each criterion to adaptation and mitigation efforts should be clarified. Also, it is necessary to explain how each criterion facilitates or thwarts urban resilience. Relative important of each criterion is another significant issue that needs due consideration. A methodology should be developed to quantify the relative weigthings. Also, it should not be forgotten that these criteria do not act in isolation and their interlinkages and how that reinforce each other should also be studied. After having a relatively comprehensive set of criteria at hand, the next stage should be developing indicator(s)to measure the overall resilience. The output of this research would help planners and decision makers to make more informed decisions.

References

