

AN OVERVIEW OF URBAN RESILIENCE: DIMENSIONS, COMPONENTS, AND APPROACHES

Mazdak Irani¹, Payam Rahnamayiezekavat²

¹ ORCID: 0000-0002-1215-538X

² ORCID: 0000-0002-2328-4726

^{1,2} School of Engineering, Design and Built Environment – Western Sydney University
Rm ED.G.135, Parramatta South Campus, Rydalmere, NSW, 2116, **Australia**

ABSTRACT


This paper investigates the theoretical and research literature on urban resilience. It examines various definitions of the concept and explores its social, economic, and institutional dimensions as components of a dynamic system. The study design was a descriptive review of relevant material collected from high quality scientific databases using the purposeful sampling method. The results indicated that the social ecology model of urban resilience provided a coherent and dynamic approach to the study of urban resilience. This model comprises economic, social, and institutional dimensions, the components of which have different functions in relation to urban resilience in the face of changes and pressures. To be effective, the system must be flexible and contain a variety of resources and functions to make predictions, deal with adverse events, and make provision for possible failures. System stability and balance require active and knowledgeable actors and institutions that enable appropriate communication between them. In this approach, a resilient city not only has the ability to absorb and withstand disasters, but also contains a variety of internal and external resources to regain balance. Resilient systems are the result of a series of decisions and actions at different times. The necessary capacities must be developed in the economic, social, and institutional dimensions to create economic stability, increase awareness and public cooperation, and develop efficient institutions to legislate for and implement urban resilience programs.

Keywords: urban resilience, resilience components, resilience approaches, economic resilience, social resilience, institutional resilience

INTRODUCTION

Urban communities are highly vulnerable to natural and man-made hazards [Lang, 2011]. Cities are complex systems that affect individual and social well-being along many dimensions – economic, social, institutional, and environmental. The physical expansion of cities and increase in the

urban population have exposed citizens to a variety of stresses, including industrial and structural changes (e.g., relocation or proximity to large industrial companies), economic crises (e.g., the financial crises of 2007–2008 and the European debt crisis of 2009), population movements, natural disasters (e.g., severe earthquakes, floods, and storms), disruption of energy supply, and changes in urban management.

mazdakirani@mail.com, p.zekavat@westernsydney.edu.au

Large cities are particularly vulnerable to natural hazards and any kind of shock can have significant economic, social, environmental, and institutional consequences for such a complex system. For example, in 2005 Hurricane Katrina in New Orleans killed more than 1,800 people and cost the US economy \$125 billion. The devastating 2011 earthquake in eastern Japan caused extensive damage, as tsunami waves devastated coastal areas and triggered a major nuclear accident at Fukushima. The estimated cost of the damage was \$210 million, and more than 17,000 people died [Chadha et al., 2006].

Cities are responsible for 60–80% of energy consumption and generate 60–80% of greenhouse gas emissions [Galderisi, 2014]. This issue is especially important in developing countries, where rates of population growth and poverty are high.

In this context, cities play a dual role, in that they are both vulnerable to and responsible for these threats which, given their scale and scope, have emerged as a global issue. Hence, it is vital that urban policies pay attention to resilience and that appropriate planning is undertaken to manage crises [Coghlan & Norman, 2004]. The present study was driven by the expectation that embedding resilience in the urban management system will enhance a community's response to risk. The aim was to investigate the social, economic, and institutional dimensions of resilience via a critical review of the research and theoretical literature on urban resilience.

MATERIALS AND METHODS

The method of narrative review was adopted to present a comprehensive analysis of the current knowledge in the field of urban resilience. The following databases were searched for relevant articles, books, and specialized reports: IEEE Science Direct, Scopus, Springer, Web of Sciences, and Google Scholar. The initial keywords applied in the search were “Resilience”, “Urban resilience”, “Institutional resilience”, “Economic resilience”, and “Social resilience”. Following preliminary analysis, the keywords “Urban system”, “Resilient city”, and “Resilience dimensions”

were added, which helped to identify other relevant publications. No time limitation was imposed in selecting the articles, but recent texts were prioritized, and items not in line with the research goals were omitted from subsequent analysis. Our continuous search yielded 145 articles and books. When duplicates and documents with thematic and content mismatch were removed, a final total of 97 articles was selected. After initial review of the documents, parts of the shortlisted publications that related to the dimensions of urban resilience were extracted and collated in a dictionary. These collected notes guided the creation of an architecture of a resilient urban community. The shortlisted papers were then re-assessed against the proposed architecture to verify its representativeness of the resilience dimensions discussed in the selected literature. Finally, as an essential success

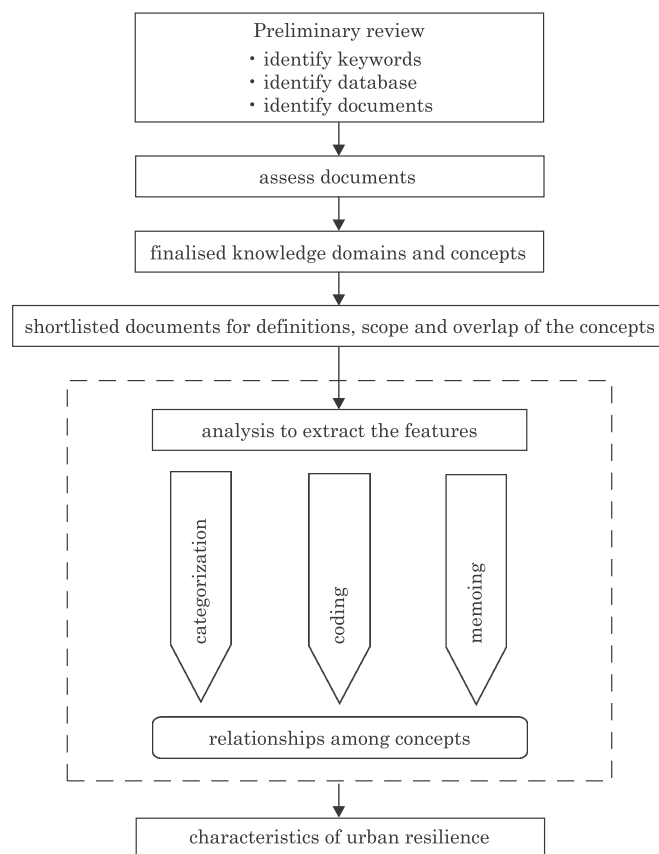


Fig. 1. Study process
Source: own preparation.

element for emergence of resilient urban community, the cooperation of the system components identified in this study were analysed. The study procedure is represented graphically in Figure 1.

THE NOTION OF URBAN RESILIENCE

As a scientific concept, the meaning and origin of the word 'resilience' is ambiguous [Adger, 2000; Friend & Moench, 2013; Lhomme et al., 2013; Pendall et al., 2010; Porter & Davoudi, 2012]. In this, it is similar to the concepts of sustainable development and governance. The lack of consensus on a specific meaning of resilience creates difficulties for researchers seeking to measure and apply the concept [Gunderson, 2000; Gunderson & Holling, 2002; Pizzo, 2015; Vale, 2014]. Nonetheless, it continues to be used by all stakeholders [Brand & Jax, 2007; Rose, 2007].

The difficulty in defining resilience is partly related to the diversity of stakeholders and the application of the concept in a range of disciplines, including physics, psychology, and ecology [Sharifi & Yamagata, 2014, 2015; Galderisi, 2014; Leichenko, 2011; Zhou et al., 2010]. In psychology, resilience refers to behaviors and characteristics that help people get along and be socially successful [Pendall et al., 2010]. In the physical and engineering sciences, it refers to the ability of a substance to return to its original situation or maintain balance after withstanding pressure. The amount of resilience of a material depends on its structure and how it operates under undesirable conditions. Therefore, resilience implies adaptability after disturbance as well as the ability to improve and correct the situation [Adger 2000; Holling, 1996].

The term 'urban resilience' refers to the adaptation of complex systems in cities [Batty, 2008; Godschalk, 2003]. In urban planning, resilience is used to refer to the urban system's capacity to manage natural and man-made hazards [Bosher & Coaffee, 2008]. Accordingly, urban resilience is discussed in studies of the urban environment from the perspective of systems theory. In a systemic approach, resilience is mainly defined as the urban ecosystem [Rogatka et al.,

2021]. Sharifi and Yamagata [2015] consider resilience as one of the dimensions of urban sustainability that maintain human-environment interactions over time. Such interactions, they propose, include social, economic, and environmental dimensions. Alberti et al. [2003] define urban resilience as the ability of cities to withstand change, create new structures, and rebuild after change. Similarly, Norris et al. [2008] define it as a set of adaptive capacities that can maintain the system's compatibility and function after a crisis [Chelleri, 2012; Resilience Alliance, 2010].

Rose [2004] distinguishes between inherent and adaptive resilience. Inherent resilience refers to performance in non-crisis periods (e.g., the market's ability to redistribute resources in price signals), while adaptive resilience relates to the system's flexibility, ingenuity, or ability to deal with critical situations.

Some researchers argue that resilience is related not only to systemic capabilities but also to human interactions with the environment. If such interactions are appropriate, they can provide long-term urban sustainability and resilience over generations [Van Andel et al., 1990; Redman, 1999]. Others emphasize that resilience not only an independent issue, but also a part of the vulnerability and urban sustainability studies [Miller et al., 2010; Turner, 2010]. Weichselgartner and Kelman [2014, p. 10] have proposed that the concept of resilience carries a positive semantic load, which has made it more attractive than other similar concepts. The Rockefeller Foundation defines urban resilience as the resilience associated with the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow despite various chronic shocks and stressors [Spaans & Waterhout, 2017].

The unifying element in these concepts of resilience is the ability of an urban environment to recover from disaster and return to its previous condition. In other words, resilience refers to the system's capacity to absorb risks and reorganize itself after exposure to risks. From this perspective, a systemic approach is required to better understand the mechanism of urban resilience. In this approach, the urban system has important capacities to absorb, adapt, reconstruct,

and learn in relation to withstanding change and return to normal conditions of the past [Carpenter et al., 2001]. Table 1 summarizes the key definitions of resilience.

Table 1. Definitions of Resilience

Author	Definition
Sharifi & Yamagata [2015]	Resilience is considered as one of the dimensions of urban sustainability that aim to maintain human-environment interactions over time
Alberti et al. [2003]	Capability of cities to absorb changes, create new structures, and reconstruct after change
Norris et al. [2008]	A set of adaptive capacities that can maintain system compatibility and function after a crisis
Rose [2004]	Distinguishes between natural resilience (related to normal conditions) and adaptive resilience (ingenuity or effort of the system to deal with critical situations)
Cote & Nightingale [2011]	Resilience arises from system characteristics that may be positive or negative and turn into a normative viewpoint
Godschalk [2003]	A sustainable network of physical systems and social relations
Campanella [2006]	The capacity of a city to escape destruction
Lamond et al. [2009]	Includes the idea that cities and towns should be able to recover from major and minor disasters quickly
Hamilton [2009]	Ability to recover and maintain the core tasks of life, business, industry, government, and social groups in the face of disasters and other hazards
Romero-Lankao & Gnatz [2013]	The capacity of urban populations and systems to withstand a wide range of hazards and stresses
Spaans & Waterhout [2017]	The capacity of urban individuals, communities, institutions, businesses, and systems to survive, adapt, and grow despite chronic shocks

Source: own preparation.

These definitions have some important commonalities. All consider resilience as a positive attribute that can be constructed or acquired by cities, communities, households, organizations, or businesses. This capacity includes specific activities such as resistance, absorption, adaptation, transformation, change, recovery, and preparedness for specific events (shocks, stresses, hazards, and disasters).

Although there is semantic overlap between the concept of resilience and those of risk exposure and vulnerability, there is a lack of agreement on the relationships among them [Berkes, 2007; Gallopin, 2006; Klein et al., 2003]. Systems with less resilience are vulnerable to stressors and shocks. In this sense, it can be said that increased resilience reduces vulnerability [Folke, 2006]. The concepts of resilience and vulnerability have different origins: resilience is derived from positivist biophysical science approaches, while vulnerability is derived primarily from structuralist frameworks in social sciences and political ecology [Miller et al., 2010]. According to Gallopin [2006], vulnerability is a broader concept than resilience and is closer to the idea of “adaptation capacity”. Most scholars consider risk exposure to be part of vulnerability, arguing that vulnerability only makes sense in relation to a particular risk [Klein et al., 2003]. Resilience is an internal or emergency aspect of complex socio-ecological systems [Folke, 2006], which makes sense in the face of stressors, shocks, recovery, and reorganization. However, its hidden characteristic is within the system and independent of risk.

CHARACTERISTICS OF RESILIENT SYSTEMS

In the systemic approach, systems must be able to perform their tasks under different conditions or create new functions for new conditions. In this context, resilience, as one of the main components of a system [Lang, 2011], provides different opportunities to respond to the dual forces of needs and pressures in abnormal situations. These opportunities can protect the system in critical situations that it has not previously encountered. The system must

also be able to absorb sudden shocks, or the cumulative effect of small stressors will eventually lead to catastrophic failure. The system should also be able to take precautions against and be prepared for possible failures. Little [2002] proposes that a city's performance in different dimensions is related to its systemic capabilities. According to Kirshen et al. [2008], connection and cooperation between the components of a system is necessary for human well-being and economic order. In resilient systems, the strength, flexibility, and functional dependence of individual systems are sufficient to maintain equilibrium in the face of disruption and return to normal conditions.

Resilient systems should be reflective, robust, redundant, flexible, resourceful, inclusive, and integrated [ARUP, 2014]. In addition to these characteristics, Galderisi [2014] identifies adaptability, diversity, learning capacity, efficacy, networks, innovation, rapidity, knowledge, and self-reliance. Suárez et al. [2016] identify the following key characteristics of urban resilience:

- Diversity of urban system components;
- Modularity in the relationship between different components of a system. A modular system consists of subgroups that have a strong relationship with each other, but a weak relationship with other subgroups;
- Tightness of feedback: The mechanisms that control the ecosystem should enable strong, rapid and effective responses to shocks;
- Social cohesion. Trust, social networks, and leadership increase individuals' capacity to deal with disorders collectively;
- Innovation: Learning and cumulative experience provide new ways to deal with change.

Other authors identify flexibility, diversity, redundancy, modularity, and safe failure as the main components of a resilient urban system [Ernstson et al., 2010; Leichenko, 2011; Liu et al., 2007; Tyler & Moench, 2012; Tabibian & Movahed, 2016].

RESILIENCE APPROACHES

Resilience approaches are strategies that seek to deploy the adaptive resources and capacities of a society to overcome the problems caused by change. These approaches focus on the internal capacity of a society to overcome harms rather than on external interventions. Resilience can be assessed on various scales: national, regional, urban area, urban, local, or household. Such a distinction is important for policymakers because resilience assessment scales can be useful in determining activities and decisions.

Pendall et al. [2007] identify four approaches to urban resilience: equilibrium, systems perspectives, path dependence, and long view. The equilibrium approach is based on the assumption that urban systems, like all other systems, have states of equilibrium that may be disrupted by internal or external factors. In this approach, the main premise is that disturbance in the system's equilibrium can bring it to a new equilibrium, provided that the system has the ability to absorb and adapt to the external changes and fluctuations.

The systems perspective involves a process of continual adjustment with four phases, each of which has a varying relationship to the three dimensions of change, namely: the availability of accumulated resources to the system; the internal association among actors or variables of the system; and resilience, which is defined as the system's vulnerability to stresses and shocks. High resilience is related to the phases of creative and flexible responses.

The path dependence approach focuses on the effects of decisions and plans on phenomena and events. In this view, equilibrium or imbalance is the result of accidental events and the actions of agents.

The long view approach addresses the issue of resilience over time. Equilibrium or imbalance in a system is seen to result from not only current events and actions, but also a series of decisions and actions at different times. Therefore, in order to better understand the subject, one must adopt a historical approach to the phenomenon.

Sharifi and Yamagata (2015) discuss resilience in relation to its application in engineering, ecological, and socio-ecological systems. In engineering, resilience refers to the robustness and resilience of a system against external disturbances and the ability to return to equilibrium. This is closely related to the engineering concepts of stability, efficiency, constancy, predictability, and reversibility to the previous status [Holling, 1996]. In this approach, a stable equilibrium exists, namely stable equilibrium [Berkes et al., 2002].

The ecological approach emphasizes the unpredictability of a system and its ability to absorb disturbances so that its basic functions are preserved. The system uses a multiple-equilibrium model to create a new state of equilibrium by absorbing fluctuations or hazards and adapting to them, which leads the system to a better state [Holling, 1996; Folke, 2006]. In this approach, resilience is considered as an indicator of a system's ability to deal with environmental shocks and stresses; hence, capacities should exist within the system to control and manage these shocks. System resources and assets can determine the adaptive status and future of the system [Holling, 2001]. The ecological approach emphasizes uncertainty, nonlinearity, and self-organization of the system [Leichenko, 2011; Alberti et al., 2003]. In other words, this approach emphasizes the system's ability to self-organize and learn from disasters to improve the situation.

In the socio-ecological approach, the system must be able to adapt to disasters through absorption, learning, and repair [Roeger et al., 2014; Cutter et al., 2013; Linkov et al., 2013; Gibson & Tarnat, 2010]. In this approach, human beings are the main force in changing the world and affect the formation of ecosystem dynamics in the local environment and in the biosphere as a whole [Folke, 2006; Kirch, 2005; Folke & Gunderson, 2010; Chelleri, 2012; Chelleri et al., 2015]. According to Gunderson & Holling (2002), the adaptive system has four periods: rapid growth and exploitation; a long phase of accumulation, monopolization, and conservation of structure; a rapid breakdown or release phase; and a short phase of renewal and reorganization.

In her summary of the theoretical literature, Galderisi [2014] distinguished four approaches: ecology and sustainability (the ecosystem's capacity and social ecology); risks and disasters (the resilience of local regions and areas against risks and disasters); economy (the resilience of the city's economic systems at the regional level and its production capacity); and climate change (the ability of cities to cope with climate change).

Another approach considers resilience as the ability of a system to plan, absorb, repair, and adapt to known and unknown threats [Cutter et al., 2013; Hollnagel et al., 2012].

Figueiredo et al. [2018] proposed a three-pronged approach to resilience (Table 2). In this model, each of the three approaches (socio ecological, disaster risk reduction, and sustainable livelihood) is preferable over the others. These approaches are complementary; meaning that activities conducted at the local level must be complemented by national policy frameworks.

The disaster risk reduction approach focuses on actions and programs at the national level. National governments must make the necessary plans and investments to produce and acquire resources that can improve the resilience of cities.

The socio-ecological approach emphasizes the urban scale and considers the city as an ecological social system. This systemic approach is based on a holistic view of the city and deals with the mechanisms of change and the relationships among various components of the system. In this approach, cities are adaptable social and technical systems consisting of different components; an appropriate combination of these components can improve individuals' quality of life. Changes are systematic (changes in one element may cause changes in other elements) and dynamic [da Silva et al., 2012, p. 5]. In other words, the analysis of urban resilience requires a holistic approach.

The sustainable livelihood approach introduced by Oxfam and the Food and Agriculture Organization (FAO) emphasizes resilience at the household level [Jennings & Manlutac, 2016]. In this approach, the well-being of individuals and families is a key component of resilience. This approach is appropriate for countries with high rates of poverty and

Table 2. Three Main Approaches to Resilience

Approach	Sample Definition of Resilience	Typical Scale of Analysis	Most Common Concepts
Disaster risk reduction	The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to, and recover from the effects of a hazard in a timely and efficient manner through the preservation and restoration of its essential basic structures and functions [United Nations,2017]	Global and national	Hazard Disaster Disaster risk
Socio-ecological	The amount of change the system can undergo while still retaining the same controls over function and structure; the degree to which the system is capable of self-organization; and the ability to build and increase the capacity for learning and adaptation [Holling & Walker, 2003]	Cities and communities	Shocks Stresses
Sustainable livelihoods	A capacity that enables households and communities to maintain a minimum threshold condition when exposed to shocks and stresses [Frankenberger et al., 2014]	Households and communities	Vulnerability

Source: Figueiredo et al. [2018].

social inequality. Available research indicates that personal wealth is one of the most important sources of human vulnerability [Jennings & Manlutac, 2016]. Poor households live in vulnerable areas, have less access to disaster protection equipment, and have very low levels of health, employment, and access to infrastructure services. These factors increase the level of vulnerability and justify attention to improving the residents' living conditions.

Other approaches focus on the level of neighborhood. This is based on recognition that spatial social discrimination and inequality create different levels of vulnerability and resilience [Cutter et al., 2014; USAID, 2016].

DIMENSIONS OF RESILIENCE

The basic concept in urban resilience is stability or a balanced combination of different components such as social, spatial, infrastructural, environmental, and cultural factors. These components stabilize the urban system and create the necessary capacity to recover followed by facing external threats [Rogatka et al., 2021].

One of the first hybrid models of urban resilience was developed in 2006 by the Multidisciplinary Center for Earthquake Engineering Research. The model was based on four dimensions of resilience: technical, organizational, social, and economic [Patal & Nosal, 2016]. Four years later, the Center proposed a model

with seven dimensions: demographic resilience, environmental/ecosystem resilience, organized government services, physical infrastructure, lifestyle and social competence, economic development, and socio-cultural capital, abbreviated to PEOPLES [Renschler et al., 2010, Patal & Nosal, 2016]. Following a systematic review of models of social resilience against disasters, Ostadtaghizadeh et al. [2015] suggested that five dimensions were paramount: social, economic, institutional, physical, and natural resilience. The institutional and social dimensions and their interrelationship have been emphasized in the literature [Agudelo-Vera et al., 2012].

ECONOMIC RESILIENCE

The economic dimension emphasizes the economic conditions of cities and neighborhoods, including employment, variety of occupations and economic resources, number of businesses, and household income. The economic dimension also reflects the situation of a city or neighborhood in relation to the global economy. Resilient cities have diverse economies, high innovative capacity, reliable infrastructure and a skilled workforce.

The most important factors in economic resilience have been identified as economic growth, sustainable livelihoods, access to housing, physical capital, health services, access to schooling, and employment opportunities [Godschalk, 2003; Pfefferbaum

et al., 2008]. The amount and diversity of economic resources are particularly important. For example, Adger [2000] showed how dependence on limited economic resources created inequality in income distribution and reduced resilience.

The effect of a disaster on well-being is not solely related to physical damage or direct adverse effects on people's lives and property. The effects on well-being also relate to the ability of an economy to cope, rebuild and, thus, minimize the economic losses. This ability, referred to as macroeconomic resilience, has two components: instantaneous resilience, or the ability to prevent large losses, and dynamic resilience, or the ability to rebuild and repair. Well-being is also affected by microeconomic resilience, which is reflected in the distribution of failures, household vulnerability, pre-disaster income, and ability to cope with shocks [Hallegatte, 2014].

The economic dimension of resilience refers to the structure of an economy as well as the level of economic security and stability. These structural elements include job skills, job opportunities, and employment rates [Burton, 2014]. Cities with strong and diverse economies survive better in a crisis than cities with weak economies [Campanella, 2006]. Consequently, creating a conducive environment for business and increasing the capacity for production, industry, and trade contribute to the development of resilience [Localize, 2009]. Domestic investment and economic diversity are evidence of a community's ability to attract and retain jobs and prevent the negative effects of recession [McAllister, 2015]. High tax revenues and strong economic networks that can attract and maintain a local workforce have also been identified as important indicators of economic resilience [Localize, 2009]. The presence of large industries and businesses can increase the capacity of a society to withstand economic crises [Sherrieb et al., 2010]. Other important factors include integration into the regional economy, economic cooperation with other regions and countries, participation of the private and public sectors in business development, and encouragement of collective action [CARRI, 2013].

Other researchers emphasize the importance of sustainable incomes and equitable distribution of income as key factors in economic resilience. Norris et al. [2008], for instance, consider economic development as a dimension of social resilience. They suggest that the equitable distribution of resources, along with mitigation of disaster risk and vulnerability and the level and diversity of economic resources, are key factors in economic resilience. However, dependence on limited natural resources may prevent cities from achieving sustainable incomes [Adger, 2000].

Rose [2004, 2009] argues that economic resilience is the result of natural resilience and resilience at the micro, meso, and macro levels of economic systems in times of crisis. He further proposes that economic resilience depends on market resilience. The capacity of the economic system to manage the risk of economic equations can increase the resilience of micro-economic actors in the market and re-empower them towards economic participation. Resilient economic systems also have the capacity to mitigate risk and support economic actors in emergencies.

SOCIAL RESILIENCE

The fact that some communities are resilient to disasters, while others are not, suggests that, other factors being constant, social capacities play an important role. Various capacities and characteristics help communities to rebuild following a disaster. Therefore, social structure should be considered as an important aspect of resilience [Drabek et al., 1981]. Social resilience refers to the dynamic system of human-environment interaction [Folke, 2006] that influences how a society can survive disasters such as hurricanes and floods [Paton & Johnston, 2006]. It recognizes that communities are ecologically, socially, and psychologically diverse. A resilient community has the ability to cope with change and maintain its core functions in the face of pressure.

The distribution of resources impacts on the vulnerability of communities. In societies where environmental damage is unevenly distributed, the social bonds that develop are too weak to mitigate

the risks [Godschalk, 2003]. Poor communities are not only at risk of death and serious injury, but are also unable to deploy facilities and support following a disaster.

Social capital is another important concept in social resilience. From the results of several case studies, Aldrich [2010, 2011] concludes that social capital plays the main role in disaster recovery; other factors, such as physical harm, population density, socio-economic status, and economic inequality, are less effective.

Disasters, as observable events in time and space, cause physical damage and disrupt day-to-day functions and populations in neighborhoods, communities or regions [Kirschenbaum, 2004]. The extent of the impact is also related to social structure, because such events disrupt the social order, potentially leading to social unrest and conflict. Therefore, it is necessary to understand the role of social networks and relationships before and after a disaster. Although natural disasters destroy all types of capital (physical, human, and social), social capital is the least affected. Accordingly, emergency efforts should primarily target social capital by treating community members as active agents for cooperation and assistance, rather than passive victims [Dynes, 2002].

Trust is an essential component of social capital [Paraskevopoulos, 2010; Shimada, 2015]. Trust has been shown to play a key role in reconstruction following a disaster. Familiarity and strong community ties strengthen trust among network members and facilitate cooperation during and after the event [Shimada, 2015]. For example, the cooperation between volunteer urban organizations, government agencies and local people in India and Japan was reported to strengthen trust and facilitate post-disaster reconstruction in India and Japan [Nakagawa & Shaw, 2004].

The criteria introduced for well-being include demographics of the city or neighborhood (age, gender, poverty, etc.), health status, amount of social capital, civic participation, and effective social connections. Social resilience has a variety of sources, including social ties and social capital, information

and communication, ability to learn, problem solving, collective action, and transformation [Berkes & Ross, 2013; Chandra et al., 2011; Pfefferbaum et al., 2017; Pfefferbaum et al., 2013; Norris et al., 2008]. In other words, it reflects the amount and diversity of available human resources [Sherrieb et al., 2010]. Other suggested social indicators of resilience include: social capital, social trust, citizens' commitment and responsibility and their participation in social networks [Chelleri et al., 2015]; attachment to place [Norris et al. 2008]; access to a safe and healthy environment [Chandra et al., 2011]; and Elimination of social inequalities by considering local culture and values.

In summary, a wide range of indicators of social resilience have been identified, namely: a culture of cooperation, a balanced demographic distribution, intergenerational relations, cultural diversity, social cohesion, self-organization, education, level of awareness, face-to-face interaction, poverty rate, social networks, income rate, population aging, place attachment, language proficiency, religious affiliation, ethical behavior, health systems, health coverage, and access to health.

Ecological adaptive social systems without the presence and proper function of agents and institutions will not have the necessary efficiency neither in maintaining the internal coherence nor in inter-systemic connections. The capacity for learning and innovation enhances the resilience of an urban system by contribution of activist and influential institutions in the system [Leichenko, 2011]. Learning involves not only transferring and sharing knowledge, but also developing and accessing education. These factors have been shown to be important contributors to resilience following accidents [Twigg, 2009].

Agents include individuals (such as farmers, consumers), households (as units of consumption, social reproduction, education, capital accumulation), as well as private and government organizations (government offices and departments, private companies, civil society organizations). They have distinct interests and can change their behavior based on strategic decisions, experience, and learning.

To understand the impact of agents, we need to take account of their advantages and limitations as well as the needs they meet. Agents' behavior can be changed but, depending on the circumstances, this change can be as difficult as changing the system's infrastructure.

Agents have access to a variety of financial, physical, natural, social, and personal resources, which are the basis of their power of action [Moser, 2006]. With more resources, the resilience capacity of the city system increases, especially in terms of social resilience. Not only individual agents, but also local governments and community organizations play significant roles in urban resilience, as they are central to planning, prevention, and coping [Satterthwaite, 2009]. In short, responsible and capable agents with high learning capacity are necessary to create a resilient city.

INSTITUTIONAL RESILIENCE

Recent resilience approaches have focused on understanding, managing, and guiding the socio-ecological system [Walker et al., 2006; Pickett et al., 2013]. This approach evokes a self-sufficient system in which human-natural and socio-ecological systems are intertwined. In this view, the urban system has internal regulating forces that protect it from external shocks and pressures. Institutional capacity is one of these important systemic capacities. The concept of institution refers to the rules that shape human behavior and economic and social interaction and exchange [Hodgson, 2006]. Institutions may be formal or informal, overt or implicit. They reduce uncertainty and create social patterns and that make behavior predictable and facilitate interaction [Campbell, 1998; North, 1990; Ostrom, 1990]. In relation to dealing with environmental stressors, institutions determine how agents and systems interact. Institutions define and regulate access to urban systems, make decisions related to urban management, and facilitate the flow of information among households, employers, local organizations, and other agents [Huntjens et al., 2012].

Weakness of the urban management and governance systems leads to functional, cognitive, and political disturbances that put obstacles in the

path of sustainable urban development [Grabher, 1993]. Adequate institutional capacities promote adaptive efficiency [North, 1990] and internal control of the urban system [Holling, 2001]. Institutions underpin relationships and processes in the urban development management system [Lowndes, 2001; Keck & Sakdapolrak, 2013]. They determine local decision-making frameworks, policies, and urban plans. Institutional planning capacity, especially planning for critical situations, is a crucial factor in creating urban resilience [Campanella, 2006]. In this context, Coaffee and O'Hare [2008] identify four steps in what they refer to as generic preparatory planning for emergencies: preparing, mitigating, recovering, and responding.

Sharifi and Yamagata [2014] propose that planning and leadership are two important institutional factors in designing a resilient city. The associated powers include: zoning regulations (the acceptable rate of development in at-risk areas); identification of requirements based on assessment of risks and vulnerabilities; human habitation in high-risk areas; risk analysis and risk mapping; control of unauthorized development; scenario-based planning; use of pressure factors; common planning; collective memory; active planning; degree of flexibility; and land ownership. They conclude that good urban governance and management includes: a focused government approach; public participation; accountability and independence; interpersonal and inter-organizational trust; inter-organizational cooperation; political stability; leadership capacity; emergency evacuation and management practices; urban networks at different levels (regional, national, transnational); and transparency.

Thus, planning capacity is an important institutional factor in this approach, which conceptualizes a city as an open, coherent, and multifaceted system, in which community stakeholders are considered as the centre of planning, and planners are seen as innovative and creative players [Collier et al., 2013].

Although governance and institutional capacity are independent dimensions, they are associated with other dimensions of resilience. Hence, the quality and efficiency of communication between and within organizations is important. Effective

leadership promotes resilience by strengthening the connections between various components of the system and developing social capital [Frankenberger et al., 2013]. Public participation in decision-making can help to legitimize and increase acceptance of urban managerial decisions and plans. Decentralization and attention to local creativity can reduce the complexities of organizational bureaucracy and make organizational activities more effective. Fostering popular participation, mobilizing local and regional forces, and facilitating the exchange of ideas, opinions, and experiences increases the community's preparedness to manage a crisis [Renschler et al., 2010; Norris et al., 2008]. The creation of a cohesive network of individuals and organizations increases the public capacity for trust and learning, and strengthens citizens' willingness to participate, maintain readiness, and cope with critical situations [Chandra et al., 2011].

Good governance is essential for the resilience of cities. To achieve such a goal, it is highly important to have a responsive city in which citizens can use technology to play an active role in urban planning processes. In order to design responsive cities, changes are needed in the role of policymakers, government experts, urban designers, and architects [Klein et al., 2016].

Ziervogel et al. (2017) consider justice and rights to be essential values for achieving resilience. They argue that resilience depends on: creating a framework based on justice and rights for vulnerable people; identifying the reasons for discrepancy between ideal justice and justice in real life and protecting the rights of all social groups; and empowering vulnerable communities and facilitating their access to rights and justice.

CONCLUSIONS

The concept of urban resilience has come to be widely deployed in academic literature and public policy. Its emergence reflects the expansion of urbanization and vulnerability of cities as a result of overpopulation, excessive consumption of natural resources, environmental degradation, economic problems such as poverty and unemployment, and natural disasters such as floods and earthquakes.

Resilience refers to the ability of a system to absorb natural and man-made pressures and stresses and return to pre-crisis conditions. A sustainable urban system must have the capacity to withstand stressors at multiple levels – individual, household, neighborhood, urban, and cross-border. Accordingly, different approaches are required.

The risk reduction approach focuses on urban resilience at the national and global levels, and considers it to be the result of macro decisions and policies at these levels. The intermediate-level socio-ecological approach addresses resilience at the level of cities and urban areas from a systematic and dynamic perspective which sees cities as adaptable social and technical systems in which the appropriate combination of components can improve individuals' quality of life. The sustainable livelihood approach addresses the issue of resilience at local and small-scale levels, such as urban households. In this approach, lack of access to beneficial urban services makes certain groups vulnerable to risks, and social inequality and poverty are decisive concepts. To create resilience capacity in cities, it is essential to provide sustainable livelihoods and meet the basic needs of vulnerable groups.

Resilience has economic, social, environmental, and institutional dimensions. Economic resilience requires a diversity of economic and industrial opportunities and the capacity to create wealth and prosperity for all members of society. Social resilience requires that citizens are active and have access to opportunities, reflecting the focus on social action within the dynamic system of human-environment interaction. Social forces, social structure and social capital are considered to be vital factors in resilience, and resource distribution is seen to have a (positive or negative) impact on vulnerability.

Economic growth, sustainable livelihoods, access to housing, physical capital, health services, education, and employment opportunities are the most important factors in economic resilience. The environmental dimension of resilience emphasizes the balance between development and environmental resources, appropriate human interaction with the environment, sufficient and reliable infrastructure,

and sufficient natural resources. The institutional dimension of resilience focuses on the quality of urban leadership and management. Resilient cities have strong leadership and long-term vision. They also have the institutions that are necessary to create effective cooperation between different sectors of urban management. Resilient cities are also characterized by various indicators of good governance, including transparency, accountability, and responsibility.

Because the performance of cities is linked to the performance of other systems, it is necessary

to adopt a systematic approach to understanding the mechanisms of urban resilience. Urban systems must have the necessary variety, flexibility and redundancy to replace functions in the face of change and external pressures, and must be able to absorb sudden shocks or the cumulative effect of small stresses to prevent major catastrophes. The relationship between system components can compensate for shortcomings in one or more of these components.

Figure 2 presents a comprehensive approach to urban resilience based on our review of relevant

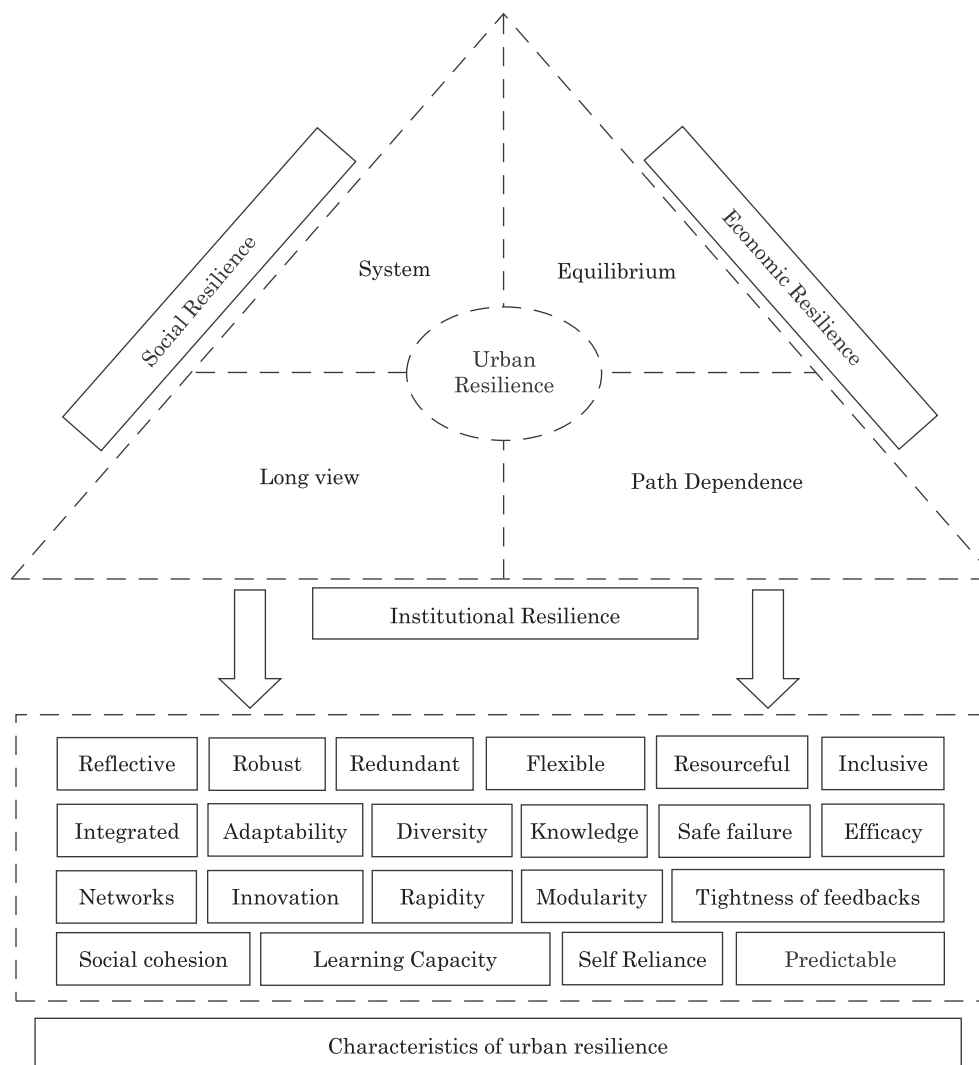


Fig. 2. Approaches, characteristics, and dimensions of urban resilience
 Source: own preparation.

literature. As can be seen, urban resilience has been examined using different approaches – equilibrium, systemic, path-dependent, and long-term – and in relation to social, economic, and institutional dimensions. Our analysis suggests that the achievement of resilience goals in all dimensions is a function of the characteristics and features of a resilient system. In other words, a resilient city is characterized by its possession of resilience strategies and characteristics such as stability, flexibility, redundancy, and resources, among others. These types of strategies are evaluated through clear and precise quantitative and qualitative research procedures. Resilient cities have sufficient capacity to respond to various events and hazards; in other words, their existing strategies are sufficiently flexible that they can be applied whenever similar circumstances occur, and are regularly evaluated and updated. The strategies of a resilient city include having sufficient resources, adopting innovative measures to overcome constraints, learning from experience, applying evidence-based information, and continuously evaluating its performance. Such systems are inclusive and able to attract stakeholders who accept responsibility for providing services to different social groups. These strategies increase the capacity of cities to absorb, adapt to, and recover from hazards.

A robust and dynamic system is necessary but not sufficient for urban resilience, since free agents can have a positive or negative impact through their choices and decisions. These decisions and actions largely reflect their social position, preferences, opportunities, and limitations, but their behavior can be influenced by rational, emotional, and past experience-based choices can influence their behavior and interactions. Knowledgeable, active, aware, and capable agents are social and cultural assets who can play a significant role in increasing urban resilience.

Urban systems and agents need efficient institutions to maximize each other's capacities and strengths. Institutions are fixed and continuous rules of behavior that enable interaction between different sectors of a society. Institutions can serve urban resilience by strengthening agents' ability to learn and innovate,

while good governance increases the capacity of the urban system to deal with risks.

In summary, building a resilient city requires the following:

- Strengthening systems to reduce their vulnerability to environmental phenomena and decrease the effects of catastrophic hazards;
- Building capacity for social agents to access and maintain supportive urban systems;
- Strengthening institutions that prevent system fragility and increase agents' capacities.

REFERENCES

- Adger, W. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), pp. 347–364. doi:10.1191/030913200701540465.
- Agudelo-Vera, C., Leduc, W., Mels, A., Rijnaarts, H. (2012). Harvesting urban resources towards more resilient cities. *Resources, Conservation and Recycling*, 64, pp. 3–12. doi:10.1016/j.resconrec.2012.01.014.
- Alberti, M., Marzluff, J., Shulenberger, E., Bradley, G., Ryan, C., Zumbrunnen, C. (2003). Integrating humans into ecology: opportunities and challenges for studying urban ecosystems. *Bioscience*, 53(12), pp. 1169. doi:10.1641/0006-3568(2003)053[1169:ihieoa]2.0.co;2.
- Aldrich, D.P. (2010). Fixing recovery, social capital in post-crisis resilience. *Journal of Homeland Security*, 6, pp. 1–10.
- Aldrich, D.P. (2011). Ties that bond, ties that build: social capital and governments in post disaster recovery. *Studies in Emergent Order*, 4(December), pp. 58–68.
- ARUP. (2014). City resilience framework. London, ARUP Group Ltd.
- Batty, M. (2008). The size, scale, and shape of cities. *Science*, 319(5864), pp. 769–771.
- Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: Lessons from resilience thinking. *Natural Hazards*, 41, pp. 283–295. doi:10.1007/s11069-006-9036-7.
- Berkes, F., Folke, C., Colding, J. (2002). *Linking social ecological systems*. Cambridge, Cambridge University Press.
- Berkes, F., Ross, H. (2013). Community resilience: toward an integrated approach. *Society and Natural Resources*, 26(1), pp. 5–20.

- Bosher, L., Coaffee, N. (2008). Editorial: International perspectives on urban resilience. *Urban Design and Planning*, 161(4), pp. 145–146.
- Brand, F.S., Jax, K. (2007). Focusing the meaning(s) of resilience: resilience as a descriptive concept and a boundary object. *Ecology and Society*, 12(1), p. 23. doi:10.5751/ES-02029-120123.
- Burton, C.G. (2014). A validation of metrics for community resilience to natural hazards and disasters using the recovery from Hurricane Katrina as a case study. *Annals of the Association of American Geographers*, 105, pp. 67–86.
- Campanella, T.J. (2006). Urban resilience and the recovery of New Orleans. *Journal of the American Planning Association*, 72(2), pp. 141–146.
- Campbell, J.L. (1998). Institutional analysis and the role of ideas in political economy. *Theory and Society*, 27(3), pp. 377–409, doi:10.1023/A:1006871114987.
- Carpenter, S., Walker, B., Anderies, J., Abel, N. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems*, 4(8), pp. 765–781. doi:10.1007/s10021-001-0045-9.
- CARRI. (2013). Building Resilience in America's Communities: Observations and Implications of the CRS Pilots. Community and Regional Resilience Institute <http://www.resilientus.org/wp-content/uploads/2013/05/CRS-Final-Report.pdf>, date: 19.07.2020.
- Chadha, R., Papadopoulos, G., Karanci, A. (2006). Disasters due to natural hazards. *Natural Hazards*, 40(3), pp. 501–502. doi:10.1007/s11069-006-9010-4.
- Chandra, A., Acosta, J., Howard, S., Uscher-Pines, L., Williams, M., Yeung, D., Garnett, J., Meredith, L.S. (2011). Building Community Resilience to Disasters: A Way Forward to Enhance National Health Security. *Rand Health Q.* 2011 Mar 1;1(1):6. PMID: 28083162; PMCID: PMC4945213. https://www.rand.org/pubs/technical_reports/TR915.html, date: 19.07.2020.
- Chelleri, L. (2012). From the «resilient city» to urban resilience. A review essay on understanding and integrating the resilience perspective for urban systems. *Documents d'analisi geogràfica*, 58(2), pp. 287–306.
- Chelleri, L., Waters, J.J., Olazabal, M., Minucci, G. (2015). Resilience trade-offs: addressing multiple scales and temporal aspects of urban resilience. *Environment and Urbanization*, 27(1), pp. 181–198.
- Coaffee, J., O'Hare, P. (2008). Urban resilience and national security: the role for planning. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, 161(4), pp. 173–182.
- Coghlan, A., Norman, S. (2004). Trans-Tasman collaboration: setting the new recovery agenda. *Australian Journal of Emergency Management*, 19(4), pp. 3–5. <https://search.informit.com.au/documentSummary;dn=375379246180862;res=IELHSS>, date: 19.07.2020.
- Collier, M.J., Nedović-Budić, Z., Aerts, J., Connop, S., Foley, D., Foley, K., ... Verburg, P. (2013). Transitioning to resilience and sustainability in urban communities. *Cities*, 32, pp. S21–S28.
- Cote, M., Nightingale, A.J. (2011). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography*, 36(4), pp. 475–489. doi:10.1177/0309132511425708.
- Cutter, S., Ash, K., Emrich, C. (2014). The geographies of community disaster resilience. *Global Environmental Change*, 29, pp. 65–77. doi:10.1016/j.gloenvcha.2014.08.005.
- Cutter, S., Ahearn, J., Amadei, B., Crawford, P., Eide, E., Galloway, G. et al. (2013). Disaster Resilience: A National Imperative. *Environment: Science and Policy for Sustainable Development*, 55(2), pp. 25–29. doi:10.1080/00139157.2013.768076.
- Da Silva, J., Kernaghan, S., Luque, A. (2012). A systems approach to meeting the challenges of urban climate change. *International Journal of Urban Sustainable Development*, 4(2), pp. 125–145. doi:10.1080/19463138.2012.718279.
- Davoudi, S., Shaw, K., Haider, L., Quinlan, A., Peterson, G., Wilkinson, C. et al. (2012). Resilience: a bridging concept or a dead end? «Reframing» Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note. *Planning Theory and Practice*, 13(2), pp. 299–333. doi:10.1080/14649357.2012.677124.
- Drabek, T.E. (1986). *Human system responses to disaster: an inventory of sociological findings*. New York, NY Springer-Verlag.
- Drabek, T.E., Tamminga, H.L., Kilijanek, T.S., Adams, C.R. (1981). *Managing multiorganizational emergency responses: emergent search and rescue networks in natural disaster and remote area settings*. University of Colorado Natural Hazards, United States of America.

- Dynes, R.R. (2002). The importance of social capital in disaster response. *Environmental Science and Policy*, 66, pp. 420–426. doi:10.1016/j.envsci.2016.
- Ernstson, H., van der Leeuw, S., Redman, C., Meffert, D., Davis, G., Alfsen, C., Elmqvist, T. (2010). Urban transitions: on urban resilience and human-dominated ecosystems. *AMBIO*, 39(8), pp. 531–545. doi:10.1007/s13280-010-0081-9.
- Figueiredo, L., Honiden, T., Schumann, A. (2018). Indicators for resilient cities, *OECD Regional Development Working Papers*, No. 2018/02, Paris, OECD Publishing, doi:10.1787/6f1f6065-en.
- Folke, C. (2006). Resilience: the emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, 16(3), pp. 253–267.
- Folke, C., Gunderson, L. (2010). Resilience and global sustainability. *Ecology and Society*, 15(4), p. 43.
- Frankenberger, T., Conostas, M., Nelson, S., Starr, L. (2014). Current approaches to resilience programming among nongovernmental organisations. 2020 Conference Paper 7. International Food Policy Research Institute (IFPRI), May 2014. <https://www.ifpri.org/publication/current-approaches-resilience-programming-among-nongovernmental-organizations>, date: 19.07.2020.
- Frankenberger, T., Mueller, M., Spangler, T., Alexander, S. (2013). Community resilience: Conceptual framework and measurement feed the future learning Agenda. Rockville, MD: Westat, https://agrilinks.org/sites/default/files/resource/files/FTF%20Learning_Agenda_Community_Resilience_Oct%202013.pdf, date: 19.07.2020.
- Friend, R., Moench, M. (2013). What is the purpose of urban climate resilience? Implications for addressing poverty and vulnerability. *Urban Climate*, 6, pp. 98–113. doi:10.1016/j.uclim.2013.09.002.
- Galderisi, A. (2014). Urban resilience: a framework for empowering cities in face of heterogeneous risk factors. *A/Z ITU Journal of the Faculty of Architecture*, 11(1), pp. 36–58.
- Gallopín, G.C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16(3), pp. 293–303.
- Gibson, C.A., Tarrant, M. (2010). A ‘conceptual models’ approach to organisational resilience. *Australian Journal of Emergency Management*, 25(2), p. 6.
- Godschalk, D.R. (2003). Urban hazard mitigation: creating resilient cities. *Natural Hazards Review*, 4(3), pp. 136–143.
- Grabher, G. (1993). The weakness of strong ties: the lock-in of regional development in the Ruhr area. In: *The embedded firm: on the socio-economics of industrial networks*. G., Grabher (ed.). London, Routledge, pp. 255–277.
- Gunderson, L.H. (2000). Ecological resilience – in theory and application. *Annual Review of Ecology and Systematics*, 31(1), pp. 425–439.
- Gunderson, L., Holling, C. (2002). *Panarchy: understanding transformations in human and natural systems*. Washington, D.C., Island Press.
- Hallegatte, S. (2014). *Economic resilience: definition and measurement*. Policy Research Working Paper, No. 6852. World Bank, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/18341>, License: CC BY 3.0 IGO, date: 19.07.2020.
- Hamilton, W.A.H. (2009). Resilience and the city: the water sector. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, 162(3), pp. 109–121.
- Hodgson, G.M. (2006). What are institutions? *Journal of Economic Issues*, 40(1), pp. 1–25. <http://www.geoffrey-hodgson.info/user/image/whatareinstitutions.pdf>, date: 19.07.2020.
- Holling, C.S. (1996). Surprise for science, resilience for ecosystems, and incentives for people. *Ecological Applications*, 6(3), pp. 733–735.
- Holling, C.S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems*, 4, pp. 390–405.
- Holling, C.S., Walker, B. (2003). *Resilience defined*. Entry prepared for the *Internet encyclopedia of ecological economics*. *The international Society for Ecological Economics*, pp. 1–3. <http://isecoeco.org/pdf/resilience.pdf>, date: 19.07.2020.
- Hollnagel, E., Pariès, J., Woods, D., Wreathall, J., Jean, P. (2012). *Resilience Engineering in Practice: A Guidebook* (1st ed.). Surrey, Ashgate Publishing.
- Huntjens, P., Lebel, L., Pahl-Wostl, C., Camkin, J., Schulze, R., Kranz, N. (2012). Institutional design propositions for the governance of adaptation to climate change in the water sector. *Global Environmental Change*, 22(1), pp. 67–81.
- Jennings, S., Ian Manlutac, J. (2016). A companion guide to resilience, Oxfam International, Guidelines and toolkits. <http://hdl.handle.net/10546/595570>, date: 19.07.2020.
- Keck, M., Sakdapolrak, P. (2013). What is social resilience? Lessons learned and ways forward. *Erdkunde*, pp. 5–19.

- Kirch, P.V. (2005). Archaeology and global change: the Holocene record. *Annual Review of Environment and Resources*, 30, pp. 409–440.
- Kirschenbaum, H. (2004). Carl Rogers's life and work: an assessment on the 100th anniversary of his birth. *Journal of Counseling and Development*, 82(1), pp. 116–124. doi:10.1002/j.1556-6678.2004.tb00293.x.
- Kirshen, P., Ruth, M., Anderson, W. (2008). Interdependencies of urban climate change impacts and adaptation strategies: A case study of Metropolitan Boston USA. *Climatic Change*, 86(1), pp. 105–122. doi:10.1007/s10584-007-9252-5.
- Klein, B., Koenig, R., Schmitt, G. (2016). Managing urban resilience. *Informatik-Spektrum*, 40(1), pp. 35–45. doi:10.1007/s00287-016-1005-2.
- Klein, R., Nicholls, R., Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*, 5(1), pp. 35–45. doi:10.1016/j.hazards.2004.02.001.
- Lamond, J.E., Proverbs, D.G., Hammond, F.N. (2009). Accessibility of flood risk insurance in the UK: confusion, competition and complacency. *Journal of Risk Research*, 12(6), pp. 825–841.
- Lang, T. (2011). Urban resilience and new institutional theory – a happy couple for urban and regional studies? *German Annual of Spatial Research and Policy*, 2010, pp. 15–24. doi:10.1007/978-3-642-12785-4_2.
- Leichenko, R. (2011). Climate change and urban resilience. *Current Opinion in Environmental Sustainability*, 3(3), pp. 164–168. doi:10.1016/j.cosust.2010.12.014.
- Lhomme, S., Serre, D., Diab, Y., Laganier, R. (2013). Analyzing resilience of urban networks: a preliminary step towards more flood resilient cities. *Natural Hazards and Earth System Sciences*, 13(2), p. 221.
- Linkov, I., Eisenberg, D.A., Plourde, K., Seager, T.P., Allen, J., Kott, A. (2013). Resilience metrics for cyber systems. *Environment Systems and Decisions*, 33(4), pp. 471–476.
- Little, R.G. (2002). Controlling cascading failure: understanding the vulnerabilities of interconnected infrastructures. *Journal of Urban Technology*, 9(1), pp. 109–123. doi:10.1080/10630730220135755.
- Liu, J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E., Taylor, W.W. (2007). Complexity of coupled human and natural systems. *Science*, 317, p. 5. doi:10.1126/science.1144004.
- Localize, B. (2009). *Community resilience toolkit: a workshop guide for community resilience planning*. Oakland, Bay Localize. www.baylocalize.org/toolkit. https://tribalclimateguide.uoregon.edu/climate-programs/community-resilience-toolkit-workshop-guide-community-resilience-planning, date: 19.07.2020.
- Lowndes, V. (2001). Rescuing Aunt Sally: Taking institutional theory seriously in urban politics. *Urban Studies*, 38(11), pp. 1953–1971. doi:10.1080/00420980120080871.
- McAllister, T. (2015). *Community Resilience Planning Guide for Buildings and Infrastructure Systems*. Vol. 2, Special Publication (NIST SP), National Institute of Standards and Technology, Gaithersburg, MD. doi:10.6028/NIST.SP.1190v2.
- Miller, F., Osbahr, H., Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., Walker, B., Birkmann, J., van der Leeuw, S., Rockstrom, J., Hinkel, J., Downing, T., Folke, C., Nelson, D. (2010). Resilience and vulnerability: complementary or conflicting concepts? *Ecology and Society*, 15(3), pp. 1–25.
- Moser, S.C. (2006). Climate change and sea-level rise in Maine and Hawai'i: the changing tides of an issue domain. IN: *Global Environmental Assessments: Information, and Influence*. R.B., Mitchell, W.C., Clark, D.W., Cash, N.M., Dickson (eds.). Cambridge, MIT, pp. 201–239.
- Nakagawa, Y., Shaw, R. (2004). Social capital: a missing link to disaster recovery. *International Journal of Mass Emergencies and Disasters*, 22(1), pp. 5–34.
- Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F., Pfefferbaum, R.L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, 41(1–2), pp. 127–150.
- North, D. (1990). *Institutions, institutional change and economic performance*. Cambridge, Cambridge University Press.
- Ostadtaghizadeh, A., Ardalan, A., Paton, D., Jabbari, H., Khankeh, H.R. (2015). Community disaster resilience: a systematic review on assessment models and tools. *PLoS Currents*, 7.
- Ostrom, E. (1990). *Governing the commons: the evolution of institutions for collective action*. Cambridge, Cambridge University Press.
- Paraskevopoulos, C. (2010). Social Capital: Summing up the debate on a conceptual tool of comparative politics and public policy. *Comparative Politics*, 42(4), pp. 475–494. doi:10.5129/001041510x12911363510150.
- Patel, R., Nosal, L. (2016). *Defining the resilient city*. New York, United Nations University Centre for Policy Research.

- Paton, D., Johnston, D.M. (2006). *Disaster resilience: an integrated approach*. Springfield, Ill., USA, Charles C. Thomas.
- Pendall, R., Foster, K.A., Cowell, M. (2010). Resilience and regions: building understanding of the metaphor. *Cambridge Journal of Regions, Economy and Society*, 3(1), pp. 71–84. doi:10.1093/cjres/rsp028.
- Pfefferbaum B.J., Reissman D.B., Pfefferbaum R.L., Klomp R.W., Gurwitsch R.H. (2008). Building Resilience to Mass Trauma Events. In: L.S., Doll, S.E., Bonzo, D.A., Sleet, J.A., Mercy (eds). *Handbook of Injury and Violence Prevention*. Springer, Boston, MA. pp. 347–358. doi:10.1007/978-0-387-29457-5_19.
- Pfefferbaum, B., Van Horn, R., Pfefferbaum, R. (2015). A conceptual framework to enhance community resilience using social capital. *Clinical Social Work Journal*, 45(2), pp. 102–110. doi:10.1007/s10615-015-0556-z.
- Pfefferbaum, R.L., Pfefferbaum, B., Van Horn, R.L., Klomp, R.W., Norris, F.H., Reissman, D.B. (2013). The communities advancing resilience toolkit (CART): an intervention to build community resilience to disasters. *Journal of Public Health Management and Practice*, 19(3), pp. 250–258.
- Pickett, S., McGrath, B., Cadenasso, M., Felson, A. (2013). Ecological resilience and resilient cities. *Building Research and Information*, 42(2), pp. 143–157. doi:10.1080/09613218.2014.850600.
- Pizzo, B. (2015). Problematizing resilience: implications for planning theory and practice. *Cities*, 43, pp. 133–140.
- Porter, L., Davoudi, S. (2012). The politics of resilience for planning: a cautionary note. *Planning Theory and Practice*, 13(2), pp. 329–333.
- Redman, C.L. (1999). *Human impact on ancient environments*. Tucson, Arizona, University of Arizona Press.
- Renschler, C., Frazier, A., Arendt, L., Cimellaro, G.P., Reinhorn, A., Bruneau, M. (2010). *A Framework for Defining and Measuring Resilience at the Community Scale: The PEOPLES Resilience Framework*. Proceedings of the 9th U.S. National and 10th Canadian Conference on Earthquake Engineering (9USN/10CCEE), 25–29 July, Toronto, Ontario, Canada, Paper No. 1827, pp. 25–29.
- Resilience Alliance. (2010). *Assessing Resilience in Social-Ecological Systems: Workbook for Practitioners (Version 2.0)*. Resilience Alliance: Halifax, NS, Canada.
- Roeger, P.E., Collier, Z.A., Mancillas, J., McDonagh, J.A., Linkov, I. (2014). Metrics for energy resilience. *Energy Policy*, 72, pp. 249–256.
- Rogatka, K., Starczewski, T., Kowalski, M. (2021). Urban resilience in spatial planning of Polish cities – True or false? Transformational perspective. *Land Use Policy*, 101, p. 105172. doi:10.1016/j.landusepol.2020.105172.
- Romero-Lankao, P., Gnatz, D.M. (2013). Exploring urban transformations in Latin America. *Current Opinion in Environmental Sustainability*, 5(3–4), pp. 358–367.
- Rose, A. (2004). Defining and measuring economic resilience to disasters. *Disaster Prevention and Management*, 13(4), pp. 307–314. doi:10.1108/09653560410556528.
- Rose, A. (2007). Economic resilience to natural and man-made disasters: Multidisciplinary origins and contextual dimensions. *Environmental Hazards*, 7(4), pp. 383–398. doi:10.1016/j.envhaz.2007.10.001.
- Rose, A.Z. (2009). *Economic resilience to disasters*. <http://text2fa.ir/wp-content/uploads/Text2fa.ir-Economic-Resilience-to-Disasters-1.pdf>, date: 19.07.2020.
- Satterthwaite, D. (2009). The implications of population growth and urbanization for climate change. *Environment and Urbanization*, 21(2), pp. 545–567.
- Sharifi, A., Yamagata, Y. (2014). Resilient urban planning: major principles and criteria. *Energy Procedia*, 61, pp. 1491–1495. doi:10.1016/j.egypro.2014.12.154.
- Sharifi, A., Yamagata, Y. (2015). A conceptual framework for assessment of urban energy resilience. *Energy Procedia*, 75, pp. 2904–2909. doi:10.1016/j.egypro.2015.07.586.
- Sherrieb, K., Norris, F., Galea, S. (2010). Measuring capacities for community resilience. *Social Indicators Research*, 99(2), pp. 227–247. doi:10.1007/s11205-010-9576-9.
- Shimada, G. (2015). The role of social capital after disasters: an empirical study of Japan based on time-series-cross-section (TSCS) data from 1981 to 2012. *International Journal of Disaster Risk Reduction*, 14, pp. 388–394. doi:10.1016/j.ijdrr.2015.09.004.
- Spaans, M., Waterhout, B. (2017). Building up resilience in cities worldwide – Rotterdam as participant in the 100 Resilient Cities Programme. *Cities*, 61, pp. 109–116. doi:10.1016/j.cities.2016.05.011.
- Suárez, M., Gómez-Baggethun, E., Benayas, J., Tilbury, D. (2016). Towards an urban resilience index: a case study in 50 Spanish cities. *Sustainability*, 8(8), pp. 1–19. doi:10.3390/su8080774.

- Tabibian, M., Movahed, S. (2016). Towards resilient and sustainable cities: a conceptual framework. *Scientia Iranica*, 23(5), pp. 2081–2093.
- Turner II, B. (2010). Vulnerability and resilience: coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20(4), pp. 570–576. doi:10.1016/j.gloenvcha.2010.07.003.
- Twigg, J. (2009). *Characteristics of a disaster-resilient community: a guidance note* (version 2). Teddington, UK, DFID Disaster Risk Reduction NGO Interagency Group.
- Tyler, S., Moench, M. (2012). A framework for urban climate resilience. *Climate and Development*, 4(4), pp. 311–326. doi:10.1080/17565529.2012.745389.
- USAID: from the American people. (2016). <https://www.usaid.gov/what-we-do/sustainable-agriculture>, date: 03.02.2016.
- United Nations, General Assembly (2017), Report of the open-ended intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction, A/71/644, United Nations General Assembly, www.un.org/ga/search/view_doc.asp?symbol=A/71/644, date: 19.07.2020.
- Vale, L.J. (2014). The politics of resilient cities: whose resilience and whose city? *Building Research and Information*, 42(2), pp. 191–201.
- Van Andel, T.H., Zangger, E., Demitrack, A. (1990). Land use and soil erosion in prehistoric and historical Greece. *Journal of Field Archaeology*, 17, pp. 379–396.
- Walker, B., Anderies, J., Kinzig, A., Ryan, P. (2006). Exploring resilience in social-ecological systems through comparative studies and theory development: introduction to the special issue. *Ecology and Society*, 11(1), p. 12. doi:10.5751/es-01573-110112.
- Weichselgartner, J., Kelman, I. (2014). Challenges and opportunities for building urban resilience. *A/Z ITU Journal of the Faculty of Architecture*, 11(1), pp. 20–35.
- Zhou, H., Wang, J., Wan, J., Jia, H. (2010). Resilience to natural hazards: a geographic perspective. *Natural Hazards*, 53(1), pp. 21–41. doi:10.1007/s11069-009-9407-y.
- Ziervogel, G., Pelling, M., Cartwright, A., Chu, E., Deshpande, T., Harris, L. et al. (2017). Inserting rights and justice into urban resilience: a focus on everyday risk. *Environment and Urbanization*, 29(1), pp. 123–138. doi:10.1177/0956247816686905.