SPATIAL AND URBAN PERSPECTIVES OF RESILIENCE. INTRODUCTION TO THEORETICAL CONCEPTS

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Abstract
The concept of resilience has been one of the dominant in recent years in the formulation of strategies for spatial planning. The relationships and interaction of resilience with sustainability have occupied a significant body of research and theoretical approaches, as has the related question of whether resilience is always beneficial for the system under consideration, or under certain circumstances may be negative, due to limitation of its adaptability. However, it seems that in recent years resilience has enriched its conceptual content and is combined with other characteristics such as adaptability, innovation and transformation. Today, resilience is seen as a critical feature of healthy ecosystems, individuals, communities, organizations and cities and is seen as essential for building a sustainable future.

This paper attempts an introduction to the theoretical concepts of resilience with special focus on its spatial component. Regional and urban resilience can help cities and communities better withstand and recover from shocks and stresses, and there are a growing number of tools and frameworks available to help guide this process. Urban resilience acquires an important specificity due to the complex urban environment that constitutes the main framework for cultural reproduction of human societies. This chapter presents definitions and interpretations of resilience, describes its conceptual enrichments and configurations, and reference is made to the main dimensions of its spatial component, which are analyzed more extensively in the rest of the presentations of the session. Thus, this presentation sets the general framework for the special session "Spatial Resilience. Conceptual approaches, Policies, Implementations" and constitutes its introduction.

Keywords: *resilience, urban resilience, physical disasters, man-made shocks, climate change*

Introduction

The concept of resilience has dominated the formulation of strategies for spatial planning in recent years. The relationships and interaction of resilience with sustainability have occupied a significant body of research and theoretical approaches, as well as the related question of whether resilience is always beneficial for the system[1] under consideration, or under certain circumstances may be negative, due to limitation of its ability to adapt (Zolli & Haly, 2012; Walker, 2011; Janssen et al, 2011). However, it seems that in recent years resilience has enriched its conceptual content and is combined with other characteristics such as adaptability, innovation and transformation. It is now an indispensable and often institutionalized element of spatial planning, while related programs such as 100 Resilient Cities (100 Resilient Cities

[1]"System" in definition can be an individual, or a collective object such as an ecosystem, a company, a city or a region.

publications: The Rockefeller Foundation 2014, 2015, 2018) have spread across the globe with significant success.

But the concept of resilience is not recent. It has roots in various fields and has evolved over time. In ecology, it began to appear in the 1960s and 1970s, as researchers noticed that some ecosystems were able to recover from disturbances, while others were not. Ecologists began studying the characteristics of resilient ecosystems and developing theories of resilience, including the idea that ecosystems have the ability to self-organize and adapt in response to changing conditions. In the 1970s, the term "resilience" began to be used in psychology to describe the ability of individuals to adapt to stress and adversity. Psychologists began studying the factors that contribute to resilience, including social support, coping skills, and personality traits. In the 1990s, the concept of resilience began to be applied to social and economic systems. Researchers began studying the resilience of communities and organizations in the face of economic shocks, natural disasters and other disruptions. This work led to the development of theories about the characteristics of resilient communities and organizations, including the importance of social capital and the ability to build adaptive capacity. In recent years, the concept of resilience has been applied more widely, including in cities, neighborhoods, but also in extra-urban space. Urban resilience, especially, has become an increasingly important topic as cities face an increasing number of challenges related to climate change, economic uncertainty, social unrest and other factors.

Resilience refers to the ability of a system to withstand and recover from shocks and stresses. Spatial resilience and urban resilience are two related concepts that focus on building resilience in natural spaces and urban environments. Site resilience refers to the ability of an area, which may include outdoor space and/or urban formations, to withstand and recover from shocks and stresses. Urban resilience, on the other hand, is a subset of spatial resilience, but with more scope for focus and analysis, and includes the resilience of entire cities and their communities. It consists of resilience across multiple systems, including social, economic and physical, and requires cooperation between sectors and stakeholders.

This chapter will attempt an introduction to the theoretical concepts of resilience and its two components, spatial and especially urban. Urban resilience acquires an important specificity due to the complex urban environment that constitutes the main framework for cultural reproduction (Lalenis and Beriatos, 2006; Lalenis, 2022).

Conceptual Approaches

Resilience: Definitions, Properties

Resilience can be defined in various ways, depending on its frame of reference, but it generally refers to the ability of a system to adapt and recover from crises, disasters, adverse events, adversity, or stressors. The term is often used across various contexts, the most common of which include psychology, ecology, engineering, business, and community dynamics. In any case, the resilience of a system involves a combination of individual or collective organizational factors that contribute to the ability to recover from difficult situations.

The concept of resilience, in its broad scope and across its various reference fields, is developed within two contexts (Pendall et al., 2010:72). The first context pertains to the analysis of equilibrium following crises, disturbances of regularity, etc., focusing on two categories of systems: a) systems presenting a single equilibrium state, emphasizing the possibility of "returning to normality," and b) systems with multiple equilibria, where the focus shifts to transitioning to "new" or "abnormal" states. The second context involves the analysis of complex adaptive systems, emphasizing the interaction of multiple factors that

produce dynamic feedback, thereby rendering a system more or less adaptable to changes—that is, more or less resilient.

Figure 1: Mechanical Resilience: "Reciprocating" system aiming to return to the pre-disaster equilibrium state. Long-lasting pressures are not taken into account (Holling 1996:35, Bates & Angeon, 2014).

Resilience in Single-Equilibrium Systems (Figure 1): Single-equilibrium systems exhibit what is termed 'mechanical resilience' and are primarily observed in the fields of psychology and in response to natural and man-made disasters. These areas analyze the tendencies, capacities, and probabilities of individuals, spatial formations, and infrastructures to recover from crises and disruptions to normality. Mechanical resilience focuses on stability in a given situation, highlighting the system's resistance to disturbance and its rate of return to its former equilibrium point (Berkes and Folke, 1998:12; Naess, 1973). The definition of resilience as related to single-equilibrium systems is perhaps the broadest and most straightforward to apply. However, this definition has its limitations. Mollenkopf (2008) highlighted this when he analyzed New York City's population recovery as a primary indicator of resilience against other cities in the Northeastern U.S. His research indicated that population recovery entailed significant economic and social costs, notably a marked increase in inequalities in the distribution of citizens' wealth, incomes, and purchasing power. Thus, the costs of recovery appeared to outweigh the benefits, challenging New York's resilience and raising the question of whether it would appear resilient by measures beyond population recovery and overall investment in the city. This suggests considering the influence on resilience beyond the parameters of single-equilibrium systems, leading to an exploration of multi-equilibrium systems.

Resilience in Multi-Equilibria Systems (Figure 2): The concept of resilience within multi-equilibria systems is predicated on the understanding that a system can possess multiple equilibria. According to Berkes and Folke (1998:12), this notion spans various scientific disciplines and contributes to an "ecological" definition of resilience distinct from other interpretations. This ecological definition of resilience brings attention to how a system's state can be disrupted by crises or equilibrium disturbances, propelling it from one state of equilibrium to another, fundamentally different one.

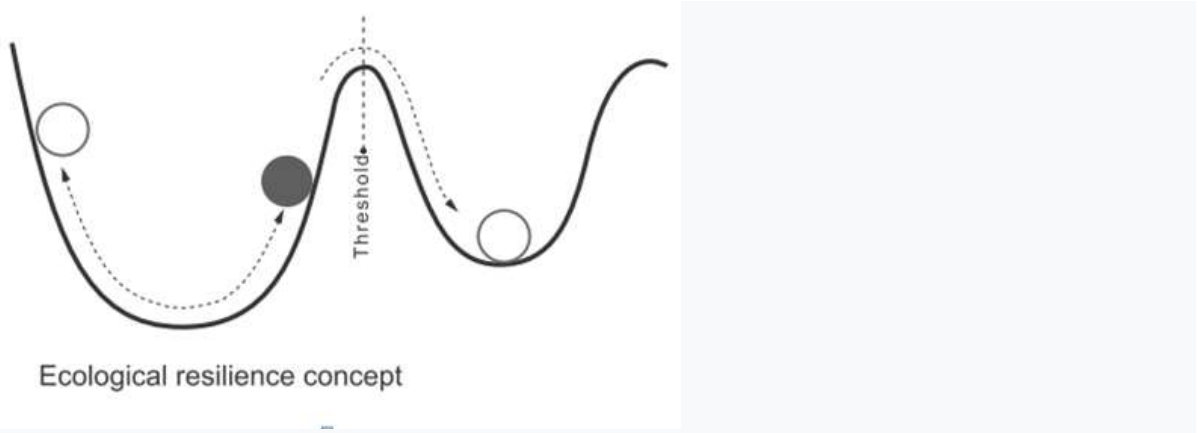

Figure 2: Resilience of ecological systems or ecological resilience: A long-lasting form of resistance with the ability to adapt to adverse influences, allowing changes from one equilibrium state to another (Holling 1996:35, Bates and Angeon, 2014).

Within such systems, the critical measure of resilience—or durability—is the magnitude, extent, or intensity of a disturbance that the system can absorb before it reaches a critical threshold, beyond which its structural characteristics start to undergo significant changes. These systems are typically complex, nonlinear, and characterized by multiple equilibria and self-organization. They exhibit sensitivity to and are particularly vulnerable to conditions of uncertainty and discontinuity. As such, resilience in this context is gauged by the system's robustness and its capacity to adapt to imposed changes (Berkes and Folke, 1998:12). Eco-resilience schemes serve as a prime example of this category, illustrating how ecological systems embody multi-equilibria resilience.

Resilience in Complex Adaptive Systems (Figure 3): Unlike the notion of resilience as merely a return to a prior state of normalcy, resilience within complex adaptive systems encompasses the capacity for change or adaptation in response to pressure and stress (Carpenter et al., 2005). Here, resilience is understood as a dynamic attribute, intrinsically linked to a process of ongoing adaptation. This continuous adaptation process precludes the existence of static equilibrium phases. Complex adaptive systems, which frequently engage with resilience, span both the social and natural sciences. Noticeably, socio-ecological sciences leverage systems analysis to deepen the understanding of evolutionary changes and socio-ecological resilience (Holling and Gunderson, 2002). As depicted in Figure 3, the adaptive cycle represents this resilience through four distinct phases of adaptation to both external and internal stresses. Each phase correlates with a specific aspect of resilience, gauged against the system's susceptibility and vulnerability to abrupt shifts, crises, and turmoil.

The conceptualization of the adaptive cycle is proposed within a two-axis framework: the "x" axis delineates the connectivity among the internal bonds between elements and actors within the system, whereas the "y" axis profiles the system's capacities corresponding to the accumulated resources available to it.

Given its construction, the adaptive cycle model precludes defining a system as consistently resilient since the levels of resilience fluctuate as the system perpetually undergoes adaptation and transformation. The pinnacle of resilience within the adaptive cycle is achieved when a system demonstrates maximal flexibility and adaptability.

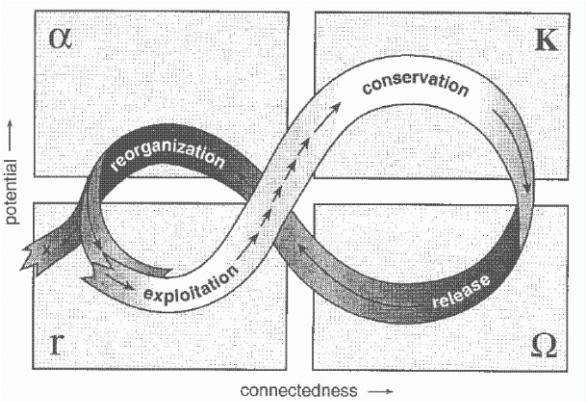

Figure 3: The four-phase adaptation cycle of ecological studies: r: Development, exploitation - existence of resources, K: Changes at a slow pace - resources unavailable, "locked", Z: Rapid changes - sudden allocation of resources, a: System limits weak - innovative interventions can be implemented. (Holling and Gunderson, 2002:34).

Structural Features of System Resilience

The resilience of a system encompasses four characteristics, as identified by Walker et al (2004:5):

1. Width or latitude,
2. Resistance,
3. Precariousness, and
4. Panarchy or external influence.

Latitude (L) refers to the system's capacity to absorb disturbances or changes following a crisis without losing its core identity and function—up to a critical point beyond which restoration becomes challenging or impossible (Figure 4).

Resistance (R) describes how easily or difficultly a system can change in response to crises, disturbances, or threats. It indicates the system's inherent "resistance" to change (Figure 4).

Precariousness (Pr) assesses how close the system's current state is to a threshold or critical point, crossing which the system's capacity for recovery is compromised (Figure 4).

Panarchy, or external influence, refers to the impact of external systems or levels—either above or below the system in question—on its resilience. For instance, in the context of a city, panarchy may relate to policy decisions at a higher governmental level or to specific events that significantly affect neighbourhoods within the city.

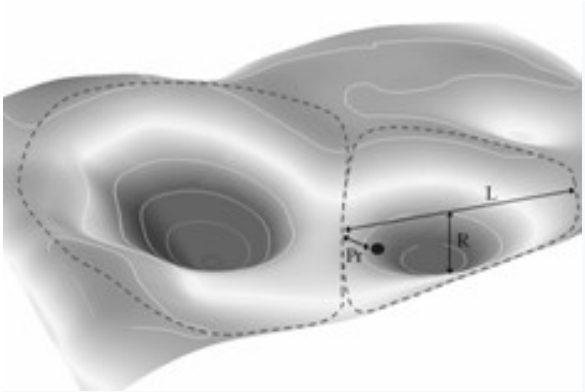

Figure 4: Three-dimensional equilibrium system, with two focus areas, one showing the present state of the system with its three components, amplitude L, resistance R and instability/hazard Pr. (Walker et al, 2004:5).

Spatial Resilience

Spatial resilience pertains to the capacity of an area, which may encompass countryside and/or urban formations, to resist, adapt, recover, and absorb disruptions or abrupt and radical changes from a previous situation. These changes could stem from natural disasters, climate change, economic crises, social or political upheavals, or significant technological changes. In essence, site resilience is the natural or man-made environment's ability to maintain its functions in the face of environmental, social, and economic challenges. It encompasses the ability to anticipate, prepare for, and adapt to changing conditions, as well as the capacity to recover from shocks. Furthermore, it involves designing natural and man-made environments with the resilience to withstand and recover from disruptions, while promoting sustainability, inclusion, and collaboration (Christopherson et al., 2010; Boschna, 2015; Peng et al., 2017; Pendall et al., 2010).

Spatial resilience represents one of the forms of resilience within complex adaptive systems, as previously discussed. The application of the adaptive cycle to spatial systems, as analyzed by Pendall et al. (2010), provides a comprehensive understanding of its operations. For example, consider the successive phases that a region undergoes during a crisis.

During the exploitation phase (phase r, exploitation, see Figure 3), as an initial phase, the region emerges from a period of intense political processes and change, possibly featuring a newly elected government with significant leadership transitions or an emerging economic base. In this high resilience environment, the region witnesses the formation of new partnerships and alliances among social and/or economic actors, adjustments to policies and governance measures, and agreements stemming from competition at levels of ideologies and power influencing the area's functions.

Such partnerships, withstanding the test of time and sequence of changes, during the subsequent maintenance phase (phase K, conservation), accumulate resources, strengthen various legal and social regulations, codify rules and procedures, and solidify practices that bolster the emerging establishment.

However, an increasing rigidity within the area exposes the system to external or internal shocks, rendering it less resilient. The region becomes sensitive and vulnerable to sudden changes, such as the emergence of a charismatic opposition leader, a significant rise in unemployment due to the sudden closure of an important local production unit, or the introduction of radical new governance methods. Under these conditions, a triggering event—like a natural disaster, premature elections, corruption scandals, or an economic crisis—provokes political, social, or economic instability. During this fluid era of rapid change and reorganization, actors and institutions vie to enhance their power positions within the system, determining winners, losers, and the nature of new structures and relationships. Amidst uncertainty, resilience peaks during the release phase (phase Ω, release).

The system's subsequent restart or continuation of functions under new conditions gradually adopts a new organizational framework—the reorganization phase (phase a, reorganization)—placing the region within a new adaptive cycle of exploitation, maintenance, release, and reorganization.

The Properties of Spatial Resilience

The characteristics that define spatial resilience include flexibility, redundancy, diversity, sustainability, equity, collaboration, and connectivity. These properties are substantiated by studies and findings from Folke et al. (2010), The Resilient Shift (2019), Olshansky et al. (2012), the United Nations (2015), and Colding et al. (2017):

1. **Flexibility and Adaptability of Infrastructure and Design**: Resilient regions demonstrate the ability to adjust their infrastructure and design to meet changing needs and conditions effectively.

2. **Redundancy of Systems and Operations**: Incorporating redundancy into systems, such as backup power sources or multiple communication channels, is crucial. It ensures operational continuity even when parts of the system are compromised.
3. **Diversity**: Promoting diverse uses and populations within a space enhances resilience by fostering a rich mix of activities and interactions, driving creativity and innovation.
4. **Sustainability**: Engaging in sustainable and environmentally friendly practices—like using renewable energy sources, reducing waste, and conserving natural resources—strengthens spatial resilience. Additionally, the ability to learn from past experiences and innovate contributes significantly to this aspect.
5. **Equity and Social Inclusion**: Ensuring inclusive accessibility to an area's spaces, so all individuals can benefit regardless of their abilities, socio-economic status, or other factors, plays a fundamental role in fostering spatial resilience.
6. **Collaboration and Connectivity**: By promoting cooperation and communication among residents, planners, and policymakers, regions can ensure that spaces are adaptable and responsive to the community's evolving needs.

Spatial resilience can be categorized into two main types: regional and local resilience. According to Martin (2012), regional resilience concerns a broader area's capacity to endure and rebound from adversity without necessarily returning to its pre-crisis state, instead seizing the opportunity to stimulate new economic growth. Foutakis (2012) views regional resilience as a spatial system's ability to steadily adjust to new conditions.

In the context of escalating natural and environmental disasters due to climate change, coupled with global economic turmoil, the significance of regional resilience has never been more pronounced. Factors like demographic composition, governance style, and the sectoral structure of the economy are critical components that influence a region’s resilience. The primary goals of regional resilience are to manage a region's response to internal shocks, adapt to novel situations, and reorganize its economic and social frameworks to ensure sustained viability and growth.

Local resilience, according to Dawley et al. (2010), emphasizes the rate of recovery of a socio-economic system from a shock, crisis, or shutdown, and the adaptability of the system, especially in adverse conditions. Adaptability refers to the reorganization of the sectors of production, consumption, and cultural reproduction under the prevailing new conditions. An important factor for successful reorganization, and therefore to improve local resilience, is the element of innovation. Local resilience is largely identical to urban resilience, since the socio-economic reference systems of local resilience, integrating the cultural reproduction sector, are essentially systems of the urban environment, systems of cities.

Urban resilience is in some ways a subcategory, and in others, it is identified with local resilience. It presents a large volume of research, reports, and literature that significantly exceed those of spatial resilience. This is mainly due to the complex and multidimensional character of the city, which is a field of coexistence and co-operation of the three main categories of actions of human societies: production, consumption, and cultural reproduction (Lalenis and Beriatos, 2006; Lalenis, 2022). Urban resilience is the main dimension of the subject of this volume and is discussed in more detail below.

Cities multiply while at the same time interdependent, so the effects of events at one point can be felt all over the planet. Within the century, most of the world's population will live in cities. Rapid and unplanned urbanization in the developing world threatens to wipe out the benefits and gains of growth. Meanwhile, climate change, refugee flows, the pandemic, war, etc., have increased the likelihood of many catastrophic events. By 2030, 325 million extremely poor people will live in 49 countries most prone to risk (Shepherd et al., 2013). These risks stem either from chronic stresses or from sudden and unexpected crises. Chronic

pressures are challenges that weaken the fabric of a city on a daily or cyclical basis. Examples include rising sea levels, unemployment, and deeper social inequality.

In this light, the city is a system of highly complex tangible and intangible networks and certainly an unstable system under constant endogenous and exogenous pressures. Natural and man-made disruptions can have a devastating impact on the city's ability to meet even the most basic needs of its citizens and can have knock-on effects. Since the beginning of 2020, cities worldwide have been at the forefront of a new crisis. In the wake of the crisis caused by the coronavirus pandemic, the debate on urban resilience took center stage in scientific circles and public discourse, and it became clear that the need to build resilient cities is more urgent than ever. Thus, today's conception of urban resilience is based on a more complex view of systems. Cities are systems that are under constant pressure and change. Within this complex scheme, the resilience of cities sometimes translates into returning to an original state and resisting transformative forces, sometimes adapting to entirely new situations, adopting new practices, and realizing that new opportunities can arise out of pressures and conflict.

Definitions of urban resilience

Urban resilience, as a subset of spatial, is one of the types of resilience in complex adaptive systems, and works in the same way as the application of the adaptive cycle to spatial systems, as analyzed by Pendall et al. (2010). It is a complex and multidimensional concept that has been defined and conceptualized in various ways in the literature. One of the most widespread definitions of Urban Resilience is that of the ARUP group, which states that:

'Urban resilience is the ability of residents, communities, institutions, businesses, and structures of a city to survive, adapt and evolve regardless of the chronic pressures and emergencies they may face' (The Rockefeller Foundation / ARUP, 2014).

The above definition provides a general framework for describing urban resilience. Individual analyses and definitions have also focused on different approaches and/or different properties of individual concepts. Such definitions are as follows:

1. Systemic urban resilience: Systemic urban resilience refers to the ability of urban systems to maintain their basic functions and adapt to changes and disruptions, even under pressure and uncertainty. This concept emphasizes the importance of interdependent and dynamic relationships between different components of urban systems, such as infrastructure, institutions, and communities (Holling & Gunderson, 2002).
2. Social-ecological urban resilience: Social-ecological urban resilience refers to the ability of urban systems to maintain their ecological integrity, social cohesion, and economic vitality, despite the disruptions they suffer. This concept recognizes the interaction between social and ecological systems and emphasizes the importance of adaptive governance and management (Folke et al., 2010).
3. Urban resilience as a process: Urban resilience as a process refers to continuous and iterative efforts to strengthen the resilience of urban systems through learning, innovation, and collaboration. This dimension highlights the importance of participatory and inclusive approaches to building resilience and recognizes the role of different actors and stakeholders (Cutter et al., 2014).
4. Urban resilience as transformation: Urban resilience as transformation refers to the capacity of urban systems to undergo fundamental change in response to systemic and long-term challenges, such as climate change and urbanization. This dimension highlights the need for radical and transformative approaches to urban development and recognizes the role of social movements and civil society in achieving change (Olsson et al., 2014).

Urban resilience is an intersection of the broader patterns of resilience development (natural environment, society, economy, artificial environment). In further detail, the fields of intersections of the above patterns are:

- Socio-ecological resilience: common field of the natural environment and society.
- Individual resilience: common field of society and the economy.
- Socio-technological resilience: common field of society, economy, and technological environment.
- Engineering resilience: common field of the technological environment and the natural environment.
- Urban resilience: common field of all the above.

Phases of Urban Resilience

In the sequence of effects of a crisis (first threatened and then realized) on an urban system, the phases of urban resilience are as follows:

- Preparation, prevention, planning a. risk mitigation and b. rehabilitation.
- Emergency response.
- Recovery, rehabilitation.
- Rebuild, recreate, adapt.

Urban Resilience Properties

Resilient urban systems resist, respond to, and adapt best to shocks and pressures when they possess seven qualities that should characterize both their modus operandi and any system, service, or natural or other resources (ARUP/Rockefeller Foundation, 2014). These are:

1. **Reflectivity**: refers to the use of experiences from people and organizations as an example for future decisions.
2. **Robustness**: refers to resistance in critical moments to overcome difficulties without major losses or damage to the operation of the city.
3. **Redundancy**: refers to the additional capacity of systems to store extra resources as reserves to be used in exceptional crises, pressures, and unforeseen situations.
4. **Flexibility**: concerns the adoption of alternative strategies in times of changing circumstances, adaptation to new circumstances, and evolution.
5. **Inventiveness**: refers to the ability to quickly find alternative goals and meet needs, mainly in special situations.
6. **Inclusivity**: emphasizes the need for broad consultation and involvement of actors and city dwellers, including the most vulnerable social groups.
7. **Interconnectivity**: refers to the degree of integration and interconnection between different city systems to be consistent, coordinated, and effective at different scales.

Measuring and Assessing Urban Resilience

In a large part of the relevant literature, the measurement and assessment of urban resilience are treated as a single chapter with common implementation tools. However, there are interesting differences between measurement and evaluation. Measurement typically involves quantifying specific indicators or variables related to resilience, such as infrastructure capacity, emergency response times, or community cohesion. On the other hand, assessment emphasizes the analysis and interpretation of data in relation to how well a city or community is prepared to withstand and recover from shocks and tensions due to crises, taking into account a range of social, economic, and environmental factors. Evaluation gives theoretical orientation to quantitative approaches to measurement. Both measurement and evaluation are essential for understanding and improving urban resilience as they are complementary and in constant interaction.

Measuring Urban Resilience

Indicative variables and indicators used to measure urban resilience include:

- Physical infrastructure capacity (e.g., the number of hospital beds or the condition of roads and bridges).
- System response times to emergencies (e.g., the time it takes for emergency services to reach a disaster site).
- Economic stability (e.g., unemployment rates or average household income).
- Access to resources (e.g., availability of food, water, or medical supplies).
- Social cohesion (e.g., the degree of trust and connection between community members).

The main frameworks and approaches used to develop urban resilience measurement methods and tools are as follows:

1. Indicator Approach: This approach involves identifying and measuring specific urban resilience indicators in different sectors such as infrastructure, social, and environmental systems. These indicators relate to access to basic services, social cohesion, and ecological diversity. An element of this approach is to quantify and benchmark urban resilience between different cities or regions (UN-Habitat, 2013).
2. Composite Indicators: Composite indicators result from a combination of different variables used to measure a complex concept like resilience (Solecki et al., 2017).
3. Network Analysis: Network analysis involves mapping and analyzing the relationships between different factors and elements of urban systems. This approach helps identify critical nodes and connections in the system and assess their resilience in cases of crises and disruptions (Ernstson et al., 2010).

At the application level, based on the above frameworks and approaches, methods and tools for measuring urban resilience have been developed. The most commonly used ones are:

1. The Urban Resilience Index (URI): An example of a composite indicator that measures the resilience of cities based on social, economic, and environmental factors. It provides a comprehensive assessment of a city's resilience considering multiple dimensions like infrastructure, environment, social cohesion, and governance. The city's overall resilience is measured using a numerical score (Güneralp et al., 2015).
2. The City Resilience Index (CRI): Developed by the Rockefeller Foundation and the ARUP team, this framework assesses urban resilience across four dimensions: Health and Well-being, Economy and Society, Infrastructure and Environment, and Leadership and Strategy. The framework is detailed into 12 objectives and 52 indicators equally distributed across the four dimensions to measure a city's resilience tailored to its specificities (The Rockefeller Foundation, 2014, 2015 & 2018).
3. The Disaster Resilience Scorecard for Cities (DRSC): Created and used by the United Nations Development Programme (UNDP), this tool assesses a city's resilience across seven dimensions including disaster and emergency management, social and health services, infrastructure, economic growth, environmental management, governance and leadership, and social resilience. Quality indicators are used under each dimension (UNDP, 2018 & 2019).
4. The Resilience Dividend Valuation Model (RDVM): Developed by the World Bank, this method assesses the economic and social benefits of resilience investments. It helps in evaluating the return on investment for resilience-building measures (World Bank, 2019a, 2019b).
5. The Urban Resilience Framework (URF): A tool developed by the United Nations Development Programme (UNDP) that assesses the resilience of cities to various shocks and tensions due to crises. It evaluates based on 12 resilience objectives including

economic, social, and environmental resilience, adapting to local characteristics (World Bank, 2013; UNDP, 2013).

Urban Resilience Assessment

Unlike measurement, urban resilience assessment takes a broader, more holistic and less quantitative approach. It involves analyzing and interpreting data on how well a city or community is prepared to withstand and recover from shocks and tensions due to crises, considering a range of social, economic, and environmental factors. The qualitative approach includes elements and methods such as the participation of specialized teams, in-depth interviews, the preparation of case studies, etc., which are crucial for a comprehensive understanding of the experiences and perceptions of urban resilience among different population and social groups. This approach contributes to the development of resilience strategies adapted to specific circumstances with broad public participation (Kabisch et al., 2016). Additionally, since each city presents unique characteristics and challenges in resilience areas, the choice of methods and tools should be tailored to the specific context and objectives of the assessment.

The main areas constituting the elements of urban resilience assessment are:

- Risk assessment: involves identifying and analyzing potential risks and their impact on the community.
- Capacity assessment: refers to identifying the strengths and weaknesses of a community's resources and capacities to respond to and recover from disasters.
- Vulnerability assessment: involves identifying the factors that make a community more vulnerable to disasters and crises.

The main frameworks and approaches used to develop methods and tools for urban resilience assessment include:

1. Scenario analysis: involves developing and testing different scenarios to assess the resilience of urban systems under varying conditions to identify potential vulnerabilities for necessary strategy adjustments (Pelling et al., 2015).
2. Resilience assessment frameworks: structured approach to assessing urban resilience involving defining indicators, collecting data, and analyzing the city's performance against these indicators. Example applications include Resilience Capacity Index (RCI) and Urban Resilience Assessment (URA).
3. Threat and risk assessments: crucial for understanding the threats and risks faced by a city, identifying both natural and man-made threats and assessing their potential impacts on urban systems (UNDRR, 2019).
4. Participatory approach: essential for assessing resilience at a neighborhood or local community level through surveys, interviews, and discussions to gather residents' perceptions, vulnerabilities, and adaptive abilities, involving diverse groups for co-creating strategies (Meerow et al., 2016).
5. Infrastructure and system assessments: assessing vulnerability, redundancy, interdependencies, and adaptive capacity of major infrastructure systems like water, energy, and transport to withstand pressures and sudden deteriorations, utilizing tools such as Infrastructure Resilience Analysis (IRA) (Pickett et al., 2017).
6. Simulation and Modeling: using simulations and digital models to assess urban system resilience by modeling interactions and behaviors, testing scenarios, and evaluating intervention effectiveness.
7. Economic assessments: evaluating the economic impact of urban system pressures, including direct and indirect losses, to inform investment decisions and prioritize resilience measures.

8. Performance monitoring: establishing monitoring systems to track urban resilience indicators over time, identify trends, and measure the effectiveness of resilience-building initiatives using key performance indicators (KPIs).

The most commonly used assessment methods and tools for urban resilience include:

1. Resilience Maturity Model (RMM): assesses the maturity of a city's resilience approach, identifying gaps and opportunities at different stages (Resilience Shift project, 2019).
2. Resilience Assessment Tool (RAT): assesses the resilience of infrastructure systems like water supply, transport, and energy using indicators (Resilience Shift project, 2019).
3. Resilience Capacity Index (RCI): quantitatively measures a city's ability to withstand and recover from system shocks (Pelling et al., 2012).
4. Urban Resilience Assessment (URA): a participatory tool involving stakeholders and citizens to assess a city's resilience across social, economic, and environmental dimensions (Asian Development Bank & Stockholm Environment Institute, 2013).
5. The 10 Essentials for Making Cities Resilient: a tool by the United Nations Office for Disaster Risk Reduction (UNISDR) providing guidance on assessing and improving city resilience with a focus on essential areas such as governance, urban planning, and public awareness (UNISDR, 2013).

Overall, measuring and assessing urban resilience are complementary processes that help cities and communities identify strengths and weaknesses, prioritize investments, and develop strategies to enhance resilience over time.

100 Resilient Cities Programme

The 100 Resilient Cities Programme is a well-known case of urban resilience being applied globally. It is an initiative of the Rockefeller Foundation that supports an international network of cities to enhance their resilience to the physical, social, and economic challenges of the current century. The program deals with both unexpected crises (emergencies) like earthquakes, heat waves, and epidemics, as well as chronic pressures (social, environmental, or economic) that weaken the urban fabric, such as unemployment, macro-economic crises, and lack of cooperation between agencies. The City Resilience Index (CRI), a tool used in the project, aids in measuring urban resilience.

As for the program, cities are encouraged to focus on four main categories/dimensions to strengthen their resilience: **Health and Well-being, Economy and Society, Infrastructure & Ecosystems, and Leadership and Strategy**.

Each of these four dimensions has three objectives, totaling twelve in all:

1. **Minimal human vulnerability**: Achieved by meeting everyone's basic needs adequately.
2. **Diversity of living and employment**: Facilitated by access to finance, skill development, business support, and social welfare.
3. **Effective safeguards for human health and life**: Based on integrated health services and emergency care.
4. **Collective identity and community support**: Achieved through community involvement, strong social networks, and social inclusion.
5. **Full security and rule of law**: Includes law enforcement, crime prevention, justice, and emergency management.
6. **Sustainable economy**: Attained through financial management, revenue diversification, attracting business investment, and emergency capital.
7. **Reduced exposure and fragility**: Achieved through environmental management, proper infrastructure, land use planning, and enforcement of regulations.
8. **Efficient delivery of critical services**: Enhanced by various amenities, ecosystem and infrastructure maintenance, and emergency planning.

9. **Reliable communications and mobility**: Ensured by diverse and affordable transport systems, ICT networks, and emergency planning.
10. **Effective leadership and management**: Facilitated by government involvement, multilateral consultations, and informed decision-making.
11. **Engaged stakeholders**: Promoted through education, information access, and knowledge to empower individuals and organizations.
12. **Integrated development planning**: Demonstrated by urban vision, integrated development strategy, and regular review of plans by interdepartmental working groups.

The method is graphically depicted as a circle, known as the ARUP cycle. Near the center, the four resilience dimensions are positioned as quadrants, each containing three objectives that move towards the perimeter. Each objective comprises five indicators tangent to the circle's rim. While the dimensions and objectives are generally applicable across most cities, the indicators can be tailored based on the unique characteristics of the city in question.

Conclusions

This chapter aimed to introduce the theoretical concepts of resilience, focusing on both spatial and urban components. Urban resilience was particularly emphasized due to the complex and multidimensional nature of the urban environment, which serves as a primary framework for cultural reproduction. Crises and disasters, whether natural or human-induced, are increasingly faced in urban settings. The recent global pandemic has starkly highlighted the complexity of urban resilience and emphasized the necessity for cooperation among multiple urban systems.

Defining the basic theoretical characteristics and properties of resilience proved challenging due to diverging conceptualizations among researchers and the continual evolution and redefinition of resilience itself. This adaptability and fluidity in the concept sometimes seem reactive to crisis-driven needs, showcasing unexplored characteristics.

Figure 6: Urban resilience framework (The Rockefeller Foundation, 2015)

Regional and urban resilience are best comprehensively understood when classified under the category of resilience in complex adaptive systems. Resilience in such systems is dynamic, tied to continuous adaptation without fixed equilibrium phases. Spatial and urban resilience, within the realm of spatial systems, exemplify the constant change and adaptation present in urban environments.

Developing resilience in natural and urban spaces necessitates an integrated approach tailored to each location's unique characteristics and challenges. This includes risk and vulnerability assessments, setting resilience vision and objectives, and implementing targeted initiatives to build capacity and enhance resilience.

Measuring and assessing resilience is intricate, involving a dynamic array of factors that are often challenging to quantify. Common metrics encompass the speed and efficacy of recovery post-disruption, the extent of social and economic disruption caused by shocks, and a system's ability to uphold critical functions during and after a crisis.

Over time, the concept of resilience has evolved in response to changing circumstances, cementing itself as a crucial aspect of sustainable and effective design. Resilience is now recognized as vital across ecosystems, individuals, communities, organizations, and cities, playing a pivotal role in crafting a sustainable future. Regional and urban resilience stand as key concepts aiding cities and communities in weathering shocks and stresses, with numerous tools and frameworks available to support this journey. Investing in resilience across multiple systems through an integrated approach can enhance sustainability, adaptability, and readiness to face future challenges.

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