MEASURING UNCERTAINTY: FACING PLACE MUTATIONS SUSTAINABLY

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ABSTRACT

Urban resilience often conflates crisis events and their adaptation processes, despite their differing characteristics, and fails to distinguish between sudden and unwanted events, leading to ambiguities. To address this, defining 'multiresilience' and 'multiadaptation' is essential for understanding a place's behaviour under multiple risk situations increasingly common in contemporary territories. Multiresilience refers to a system's ability to respond to the simultaneous presence of multiple risks by considering the unique aspects of the place, the characteristics of each risk and the participation of various stakeholders with an emphasis on inclusion, ultimately aiming to return to the initial state. In contrast, multiadaptation describes a system's capacity to react to unforeseen multi-risk situations by establishing a new equilibrium that accounts for territorial specificities, types of risks, involved actors and emerging needs, also with a focus on inclusion. To practically explore these concepts, a methodology was developed within the PRIN 2020 research project, 'Sustainable Modelling of Materials, Structures, and Urban Spaces', under the author's responsibility of the Urban Impact Unit. Principles for multiresilient planning were identified through case studies utilising this methodology. These principles serve as a flexible tool for designing spaces that are resilient and adaptable to unexpected multi-risk events. Additionally, the Dynamic Place Index (DPI) was created to measure the multiresilience and multiadaptation of an area. This index evaluates the flexibility of different parts of a multi-risk area to accommodate project interventions based on current and emerging needs. Starting from these premises, the study presents the methodology, principles and the DPI, detailing how the index assesses the flexibility of areas affected by multiple concurrent risks to facilitate effective project interventions. This approach ensures that urban spaces are both resilient and adaptable to future challenges.

Keywords: urban uncertainty, multi-risk, multiresilience, multiadaptation, dynamic place.

1 INTRODUCTION

Urban resilience is a critical concept in urban planning and disaster management, but it often conflates the events that cause crises with the processes of adapting to them. Despite their differing characteristics, sudden events and gradual, unwanted changes are frequently treated similarly, which can lead to ambiguities in planning and response strategies [1]. To address this issue, it is essential to define the concepts of 'multiresilience' and 'multiadaptation' to better understand how urban spaces behave under multiple risk situations, which are increasingly common in contemporary territories [2]. Multiresilience refers to the ability of a system to respond effectively to the simultaneous presence of multiple risks. This concept takes into account the unique characteristics of the place, the specific nature of each risk, and the participation of various stakeholders with an emphasis on inclusion [3]. The ultimate goal of multiresilience is to return to the initial state after the crisis has been managed. This process involves a comprehensive understanding of the interconnections between different risks and the cumulative impact they can have on urban systems [4].

For example, an urban area might face environmental risks such as flooding and air pollution, alongside social risks like economic inequality and public health crises. Multiresilience would involve creating strategies that address these risks collectively, ensuring that the solutions are tailored to the specific needs and characteristics of the area.

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This could include enhancing green infrastructure to manage flooding while improving air quality and promoting social programs to address economic disparities [5].

Multiadaptation, on the other hand, describes a system's capacity to react to unforeseen multi-risk situations by establishing a new equilibrium. This new balance takes into account the specificities of the territories, the types of risks involved, the actors participating in the response, and emerging needs, always with a focus on inclusion [6]. Unlike multiresilience, which aims to return to a previous state, multiadaptation accepts that the post-crisis state might be different and potentially better suited to the new conditions [7].

In practice, multiadaptation might involve rethinking urban design to incorporate flexible spaces that can serve multiple purposes depending on the needs of the moment. For instance, public spaces could be designed to accommodate social distancing during a pandemic while also being usable for community events in normal times. This approach ensures that urban areas are not only resilient to specific known risks but are also adaptable to unforeseen challenges [8].

To practically explore these concepts, a methodology was developed within the PRIN 2020 research project, 'Sustainable Modelling of Materials, Structures, and Urban Spaces', #20209F3A37 research project within the Urban Impact ISMed-CNR Unit – of which the author is responsible – and the related agreement between Sapienza University of Rome and ISMed-CNR. This methodology was designed to identify principles for multiresilient planning through case studies, providing a flexible tool for designing spaces that are resilient and adaptable to unexpected multi-risk events [9].

The principles identified from these case studies emphasise the importance of integrating risk assessment into urban planning processes. This involves not only identifying and mitigating existing risks but also considering how different risks might interact and compound each other. For example, a flood mitigation project might also need to address potential health risks from waterborne diseases and the economic impacts on vulnerable populations [10].

In addition to developing planning principles, the research project introduced the Dynamic Place Index (DPI) to measure the multiresilience and multiadaptation of an area. The DPI evaluates the flexibility of different parts of a multi-risk area to accommodate project interventions based on current and emerging needs [11]. This index can serve as a valuable tool for urban planners and policymakers, helping them prioritise interventions and allocate resources more effectively.

The DPI considers various factors, including the physical characteristics of the area, the types of risks present, the socio-economic conditions, and the existing infrastructure. By analysing these elements, the index provides a comprehensive picture of the area's resilience and adaptability. For instance, an area with robust social networks and strong community engagement might score higher on the DPI, indicating a greater capacity for collective action and recovery [12]. The methodology and the DPI were applied to several case studies within the PRIN 2020 project, providing valuable insights into their practical application. These case studies demonstrated how urban areas could be designed and managed to improve their resilience and adaptability to multi-risk situations also by enhancing their cultural resources [13]–[15].

2 MAPPING UNCERTAINTY

The methodology developed for analysing multi-risk environments involves a structured process consisting of nine distinct steps, six dedicated to analysis and three to design [2], [12]. The primary objective of this method is to identify existing or potential risks – both singular and multiple – that could impact public spaces. It also aims to pinpoint the factors

contributing to these risks, understand how users perceive them, and develop interventions for both adapting to and enhancing these spaces [10]. The final outcome of this methodology is presented through two comprehensive mosaic-maps. One map integrates all the collected data to create a detailed mosaic of risks, contributing factors, and user perceptions. The other map outlines proposed interventions for both adaptation and enhancement [5].

The initial step focuses on analysing the area to identify present or presumed urban risks. This identification process uses a specific form to observe the environment and quantify the risks as slight, medium, or significant. The risks detectable through observation include degradation, environmental, social, cultural, anthropic, seismic, health, low liveability, insecurity and the risk of loss of identity of places [6]. The goal is to create a detailed risk profile of the area by systematically observing and categorising these risks [16].

Following the identification of risks, the second step examines the elements and factors that influence or may influence these risks [16]. This qualitative survey relies on detailed observation to determine which factors are contributing to the emergence or potential emergence of various risks. This step might uncover, for instance, that poor waste management practices significantly contribute to environmental risk, while social isolation exacerbates the risk of insecurity. The qualitative nature of this survey ensures that the analysis captures the intricate interplay of factors within the urban environment [17].

The third step looks at the possible effects when multiple risks identified in the first step coexist. The analysis involves creating a database to track the types of risks, their combined effects, and the extent of these effects (slight, medium, or notable). For instance, in an area with seismic risk and poor design regarding cultural identity, the space may fail as a socialisation hub due to compounded insecurity and a lack of cultural relevance [14]. This step quantifies these effects, providing a robust framework for understanding the complex dynamics of urban risks [8].

Understanding user perception is vital, and this is achieved through a risk perception questionnaire. The questionnaire aims to gauge how users perceive the identified risks, whether they see them as permanent or transient, and how they believe they can contribute to mitigating these risks. The questions cover general perceptions of the place, specific perceptions of identified risks, their permanence, potential citizen contributions to risk resolution and overall quality of the place [18]. This feedback is invaluable for tailoring interventions to address public concerns and enhance user engagement in the risk management process [19].

The fifth step involves identifying existing plans, programs, and policies related to the area. This includes a comprehensive review of any actions aimed at mitigating present or potential risks, covering various scales and sectors. The resulting mosaic provides a clear picture of how well the current initiatives address the risks, highlighting any gaps that need to be addressed in future interventions [20], [21].

Next, the methodology identifies the quality elements of the place, such as historical monuments, public spaces, greenery, and historic urban fabric. This step combines the presence of these elements with their current usage, determining whether the place is a valuable resource and its potential for flexible use. For example, a historic square might be underutilised due to poor maintenance but could be revitalised through targeted interventions. The outcome is a mosaic showcasing the quality elements and their uses, providing a foundation for identifying potential enhancements [15], [22].

The seventh step involves creating a map that consolidates all identified risks, contributing factors, risk perception results, and quality elements. This comprehensive mosaic-map serves as a visual representation of the multi-risk environment, integrating all previous analyses into a cohesive whole. Indeed, it highlights the various risks associated with public spaces and

the factors influencing them, providing a detailed overview of the area's risk profile [4] serving as a crucial tool for planning and intervention [11].

In the eighth step, the dynamic potential of the area is identified by analysing the multi-risk map [1]. This step identifies areas with the greatest dynamic potential for adaptation and improvement. By analysing the multi-risk map, researchers pinpoint flexible spaces suitable for resilience projects. Furthermore, it highlights areas where intervention is most needed, providing a strategic focus for enhancing the liveability of public spaces. For example, an underused park might be identified as a potential site for community engagement and resilience-building activities [3]. On the basis of the results of this phase the DPI is calculated, as will be shown in Section 4.

The final step involves identifying dynamic project interventions for the areas highlighted in the previous step. These interventions aim to adapt to existing and potential risks while enhancing the quality of public spaces. The result is a dynamic map outlining flexible, actionable steps for improving urban environments. Each intervention is tailored to address specific risks and leverage the identified quality elements, ensuring a holistic approach to urban resilience and enhancement [23], [24].

3 KEY FACTORS AND PRINCIPLES

The implementation of multiresilient planning necessitates a shift from traditional, top-down approaches to more flexible, inclusive, and iterative processes [25]. Key factors in this approach include inclusivity, flexibility, redundancy, diversity, and local knowledge.

Inclusivity in planning ensures that all voices are heard, and the needs of marginalised groups are addressed. This can be achieved through participatory planning processes that engage community members in meaningful ways [26]. Workshops, questionnaires, public consultations, and collaborative platforms can facilitate this engagement, allowing stakeholders to contribute their knowledge and perspectives [27].

Flexibility in urban planning involves designing infrastructures and policies that can be easily adapted or modified in response to changing conditions [28]. This might include the use of modular construction techniques, adaptable public spaces, and policies that can be updated based on new information or emerging risks [29]. Flexibility ensures that urban systems remain responsive and resilient in the face of uncertainty.

Redundancy involves creating multiple pathways and backup systems to prevent total system failure [30]. In practice, this might mean designing urban transportation networks with multiple routes and modes of transport, ensuring that critical services like healthcare and communication have backup systems, and developing decentralised energy systems that can operate independently in case of a central grid failure [11].

Diversity in risk management strategies increases the likelihood that at least some solutions will be effective in any given scenario [31]. This could involve a mix of structural and non-structural measures, such as building flood defences while also enhancing natural floodplains, promoting economic diversification to reduce reliance on a single industry, and fostering social networks that can provide support during crises [31].

Local knowledge and practices are invaluable resources for urban resilience [32]. Traditional and local knowledge often contain insights into sustainable practices and risk management that have been developed over generations. Integrating this knowledge with modern technologies and practices can lead to more culturally appropriate and effective solutions [33].

The various case studies undertaken to test the method have led to the development of key principles for multiresilient planning. These principles are based on the idea that risks can serve as opportunities to reassess and enhance aspects of a territory, positioning resilience as

a vital component of sustainable regeneration. The case studies include Cittaducale and Leonessa in the Lazio Region, as well as Siena, Naples, Paris, Madrid, Copenhagen and New York. These locations were selected due to the presence of one or more existing or potential risks: Cittaducale and Leonessa face seismic risks and depopulation; the historic centres of Siena, Naples, and Madrid grapple with issues stemming from mass tourism and globalisation; Copenhagen and New York contend with flood risks and potential loss of place identity; and Paris deals with mass tourism.

1. The identification of risks and potential damages should be conducted with reference to both single events and multiple potential events that may occur simultaneously. This comprehensive approach ensures that planning accounts for complex scenarios where different types of risks intersect. For example, a city might face the simultaneous threats of flooding, urban unliveability and infrastructure failures. Identifying these risks collectively helps in creating more robust and integrated resilience strategies. Tools such as risk matrices and scenario planning can be utilised to assess and prioritise these risks effectively.
2. Understanding the perception of risk among the population, or more generally, the users of a place, is a fundamental element in the study of dangers and risks. This perception must be detected through tailored questionnaires designed to capture the nuances of how different groups perceive and react to various threats. These surveys should be inclusive, ensuring representation from all demographics, including age, gender, socioeconomic status, and cultural background. Insights gained from these perceptions can guide the development of targeted communication strategies and interventions that resonate with the community's concerns and expectations.
3. Fragile individuals, including the elderly, children, people with disabilities, and those with chronic illnesses, must be given particular consideration both in the survey of their perception of risk and in the design of adaptation measures tailored to their needs. These groups are often more vulnerable to the impacts of disasters and less able to respond effectively. Therefore, adaptation strategies must include specific provisions such as accessible shelters, priority evacuation plans, and medical support tailored to these populations. Engaging with these communities directly to understand their unique challenges and incorporating their feedback into planning processes is essential.
4. The survey of urban qualities, including cultural heritage, materials, and equipment, is vital for multi-resilience/adaptation projects and policies. These elements should be transformed into opportunities to improve liveability. For instance, historical buildings can be retrofitted to withstand natural disasters while preserving their cultural significance. Similarly, existing urban infrastructure can be upgraded to serve dual purposes, such as public parks that also function as flood basins. Integrating these urban qualities into resilience planning not only protects valuable assets but also enhances the overall aesthetic and functional quality of the urban environment.
5. The multi-resilience/adaptation project must be constantly monitored to foresee sudden events and react sustainably. Continuous monitoring involves the use of advanced technologies such as sensors, satellite imagery, and data analytics to track environmental changes and urban dynamics in real-time. Establishing an urban observatory or resilience hub that collects and analyses data can provide timely alerts and insights, enabling proactive measures rather than reactive responses. Regular audits and updates to resilience plans based on the latest data and feedback are also crucial for maintaining their effectiveness.

6. Flexibility is one of the essential characteristics of the multi-resilience/adaptation project. This flexibility must be understood in an inter-scalar manner (from the building to the city) and an interfactorial way, integrating urban, socio-economic, cultural, and environmental aspects. For example, a flexible urban plan might include modular housing that can be quickly assembled or disassembled, green spaces that can be adapted for different uses, and policies that allow for rapid reallocation of resources in times of crisis. This multi-dimensional flexibility ensures that urban areas can adapt to a wide range of scenarios and changes over time.
7. Flexibility of public spaces should be supported through suitable both pedestrian and cycle paths. This involves creating environments that are adaptable, accessible, and able to serve a wide range of purposes for diverse groups of people. One of the most effective ways to achieve this is through the incorporation of suitable pedestrian and cycle paths. These paths are essential in enhancing the usability, safety, and overall appeal of public spaces.

   Moreover, this supports environmental sustainability by encouraging non-motorised forms of transportation and can help reduce traffic congestion, lower carbon emissions, and promote healthier lifestyles by encouraging walking and cycling. By thoughtfully designing public spaces with these considerations in mind, communities can create vibrant, dynamic environments that cater to the needs of all residents and visitors, fostering a sense of community and improving overall quality of life.
8. In the context of multi-adaptation design, ensuring accessibility to all public spaces must be a priority. This means that every environment, area, or structure intended for public use should be designed to be easily accessible to people of all ages and with varying physical, cognitive, and sensory abilities. It is essential that there are no architectural barriers or obstacles that could limit the use of public spaces by individuals with disabilities, the elderly, parents with strollers, or anyone with specific mobility needs. Accessibility must be considered a fundamental aspect from the earliest stages of design, including ramps, elevators, tactile paths, and clear and readable signage. Additionally, attention must also be paid to sensory aspects, ensuring, for example, adequate lighting, controlled acoustics, and tactile surfaces to facilitate orientation and usability of spaces. Only through a determined and conscious commitment to inclusivity can a truly open and welcoming environment for all citizens be created, thereby promoting participation and social integration.
9. A multi-resilience/adaptation project cannot be universally applied even if characterised by the same risks. Each site, whether a historic centre, suburb, or regeneration area, has its own peculiarities that must be respected. Tailoring projects to the unique characteristics of each site involves understanding the local context, community needs, and existing infrastructure. This bespoke approach ensures that interventions are culturally appropriate, socially accepted, and technically feasible. For instance, flood management strategies in a historic district might prioritise preserving architectural heritage, while those in a suburban area might focus on green infrastructure to manage stormwater.
10. Effective communication of dangers, risks, and resilience/adaptation projects, plans, and policies is essential. This communication must be appropriate for all age groups and abilities. Using a variety of channels and formats, including visual aids, interactive tools, and clear, jargon-free language, ensures that information is accessible to everyone. Public awareness campaigns, educational programs, and community workshops can enhance understanding and engagement. It's also important to establish feedback

mechanisms so that the community can voice their concerns and contribute to the resilience planning process.

11. New technologies must be leveraged to support the communication of risks and dangers. Technologies such as Geographic Information Systems (GIS), mobile apps, and social media platforms can disseminate information quickly and accurately. For example, GIS can be used to create interactive risk maps that show areas vulnerable to different hazards, while mobile apps can send real-time alerts and updates to residents. Social media can facilitate two-way communication between authorities and the public, allowing for rapid dissemination of information and collection of feedback.
12. The disclosure of all measures adopted or to be adopted in the case of a crisis should be clearly and widely illustrated through dedicated web portals, apps, social networks, sensors, and interactive maps. Transparency and accessibility of information are crucial for building trust and ensuring that the public is well-informed and prepared. Web portals can provide comprehensive information about resilience plans, resources, and emergency procedures. Apps can offer personalised alerts and guidance based on users' locations and profiles. Sensors and interactive maps can visualise real-time data on environmental conditions and infrastructure status, helping residents make informed decisions during crises [23].

4 THE DPI

The DPI is an index designed to measure the multiple resilience and adaptation capacities of urban areas. It provides a comprehensive assessment of how well different parts of an area can handle various risks simultaneously, also considering the possibility of unexpected mutations. The DPI evaluates several key factors, including risk exposure, adaptive capacity, response mechanisms, recovery potential, and stakeholder participation.

Risk exposure is a measure of the degree to which a place is exposed to different types of risks. This includes natural disasters like earthquakes and floods, socio-economic challenges such as poverty and unemployment, liveability problems, namely urban health, accessibility, and presence of green areas. Assessing risk exposure involves mapping out these risks and understanding their potential impacts on the urban area.

Adaptive capacity refers to the ability of local systems to adapt to changing conditions and unexpected events. This includes the social, economic, urban and infrastructural components of the urban area. For example, a city with strong social networks, diversified economies, and resilient infrastructures is likely to have higher adaptive capacity.

Response mechanisms are the strategies and systems in place to manage and mitigate risks. This includes the presence of emergency response plans and community-based initiatives. Evaluating response mechanisms involves assessing the effectiveness and efficiency of these systems in dealing with different types of risks.

Recovery potential is the ability of a place to recover and return to a functional state after a disruptive event. This involves assessing the speed and quality of recovery efforts, as well as the long-term sustainability of the recovery processes. Factors such as the availability of resources, the capacity of local institutions, and the resilience of infrastructures play a crucial role in determining recovery potential and in transforming it in opportunity for regeneration and enhancement of cultural resources.

Participation measures the level of engagement and involvement of both people and various stakeholders in resilience and adaptation planning. This includes government agencies, businesses, community organisations, and individual citizens. High levels of stakeholder participation indicate a more inclusive and collaborative approach to resilience building, supporting co-design with all the involved actors.

Accordingly, the DPI is calculated using the aforementioned method, which involves identifying the difference between various elements collected for the mosaic map in step 8. This mosaic map highlights areas with the greatest dynamic potential for adaptation and improvement.

In this mosaic, several factors are considered:

- Present and potential risks, both real and perceived.
- Underused or wide public spaces.
- Streets with wide sections suitable for creating pedestrian and cycle paths.
- Both tangible and intangible cultural resources observed during surveys or revealed by questionnaires.
- Public spaces that are distant from the study area but potentially connected to it.

Each of these elements is assigned a weight, ranging from a minimum of 1 to a maximum of 5. The DPI is determined by calculating the difference between the weighted risks and the elements of flexibility. The DPI range varies from 1 to 50, where 1 represents the minimum dynamic potential and 50 represents the maximum.

For example, the presence of environmental, depopulation, and isolation risks might be assigned a combined weight of 15. On the other hand, a location with many underused or wide public spaces, nearby large streets suitable for pedestrian and cycle paths, and proximity to valuable cultural heritage might receive a combined weight of 50. In this case, the DPI would be calculated as 50 (flexibility elements) minus 15 (risks), resulting in a DPI of 35. This index provides a quantifiable measure of an area's potential for dynamic adaptation and improvement, taking into account both the challenges and opportunities present in the environment.

The DPI can be applied to different urban contexts to evaluate and enhance their resilience and adaptability. By using the DPI, urban planners and policymakers can identify areas that require improvements, allocate resources more effectively, and design interventions that are aligned with both current and emerging needs.

For example, in a coastal city facing the dual threats of sea-level rise and economic decline, the DPI can be used to assess the city's risk exposure, adaptive capacity, response mechanisms, recovery potential, and stakeholder participation. This assessment can help identify specific vulnerabilities, such as inadequately protected coastal areas or economically dependent communities. Based on these findings, targeted interventions can be designed to address these vulnerabilities, such as investing in coastal defences, diversifying the local economy, and enhancing community engagement in resilience planning.

In another scenario, a rapidly growing urban area might use the DPI to evaluate its capacity to handle the pressures of population growth, infrastructure development, and environmental sustainability. The DPI can help identify gaps in urban planning and management, such as inadequate housing, insufficient public services, presence of underused public spaces, and environmental degradation. Interventions can then be designed to address these gaps, such as developing affordable housing projects, creating liveable public spaces, expanding public services, and implementing green infrastructure initiatives.

5 CONCLUSION

In conclusion, the concepts of multiresilience and multiadaptation, along with the principles of multiadaptation planning and the DPI, provide a robust framework for understanding and enhancing urban resilience. This framework acknowledges the complexity and interconnectedness of contemporary risk scenarios and offers practical tools for creating

more resilient and adaptable urban environments. As urban areas continue to face increasing and multifaceted risks, adopting such a comprehensive approach will be essential for ensuring their long-term sustainability and well-being.

By embracing the key factors of inclusivity, flexibility, redundancy, diversity, and local knowledge, urban planners and policymakers can create resilient urban systems that are capable of withstanding and adapting to a wide range of risks. The DPI serves as a valuable tool for assessing and enhancing the resilience and adaptability of urban areas, providing a comprehensive and holistic understanding of their capacities and vulnerabilities.

Ultimately, building urban resilience is not just about preparing for and responding to specific risks, but about creating dynamic and adaptable urban systems that can thrive in the face of uncertainty and change. By fostering a culture of resilience and adaptation, cities can become more sustainable, equitable, and vibrant places for all their inhabitants.

The DPI and the comprehensive framework for multi-resilience and adaptation planning provide essential tools and principles for managing the complex risks that urban areas face. By integrating vulnerability analysis, adaptive capacity, and preventive measures, the DPI offers a holistic approach to enhancing urban resilience and adaptability. Implementing the DPI in urban planning not only helps identify and prioritise areas for intervention but also fosters a proactive and inclusive approach to building resilient communities. As cities continue to grow and face new challenges, the principles and index outlined in this framework will be crucial for creating sustainable, liveable, and resilient urban environments.

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REFERENCES

[1] Davoudi, S. et al., Resilience: A bridging concept or a dead end? *Planning Theory and Practice*, **13**(2), pp. 299–333, 2012.

[2] Cutter, S.L. et al., *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, Cambridge University Press: Cambridge, 2012.

[3] Adger, W.N., Arnell, N.W. & Tompkins, E.L., Successful adaptation to climate change across scales. *Global Environmental Change*, **15**(2), pp. 77–86, 2005.

[4] UNDRR, *Global Assessment Report on Disaster Risk Reduction*, United Nations Office for Disaster Risk Reduction: Geneva, 2019.

[5] Gencer, E.A., *The Interplay between Urban Development, Vulnerability, and Risk Management: A Case Study of the Istanbul Metropolitan Area*, Springer: Dordrecht, 2013.

[6] Pelling, M., *Adaptation to Climate Change: From Resilience to Transformation*, Routledge: London, 2011.

[7] Satterthwaite, D., Climate change and urbanization: Effects and implications for urban governance. United Nations Expert Group Meeting on Population Distribution, Urbanization, Internal Migration and Development: New York, 2008.

[8] Renn, O., *Risk Governance: Coping with Uncertainty in a Complex World*, Earthscan: London, 2008.

[9] UN-Habitat, *New Urban Agenda*, United Nations Human Settlements Programme: Nairobi, 2017.

[10] Birkmann, J., *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies*, United Nations University Press: Tokyo, 2013.

[11] Godschalk, D.R., Urban hazard mitigation: Creating resilient cities. *Natural Hazards Review*, **4**(3), pp. 136–143, 2003.
[12] Leichenko, R. & O'Brien, K., *Environmental Change and Globalization: Double Exposures*, Oxford University Press: Oxford, 2008.
[13] Cutter, S.L., Boruff, B.J. & Shirley, W.L., Social vulnerability to environmental hazards. *Social Science Quarterly*, **84**(2), pp. 242–261, 2003.
[14] Alexander, D., *Principles of Emergency Planning and Management*, Oxford University Press: Oxford, 2002.
[15] Jacobs, J., *The Death and Life of Great American Cities*, Random House: New York, 1961.
[16] OECD, *Boosting Resilience through Innovative Risk Governance*, OECD Publishing: Paris, 2014.
[17] Wisner, B. et al., *At Risk: Natural Hazards, People's Vulnerability and Disasters*, Routledge: London, 2004.
[18] Slovic, P., *The Perception of Risk*, Earthscan Publications: London, 2000.
[19] Slovic, P., *Perception of Risk*, Science, **236**(4799), pp. 280–285, 1987.
[20] Tschakert, P. & Dietrich, K.A., Anticipatory learning for climate change adaptation and resilience. *Ecology and Society*, **15**(2), p. 11, 2010.
[21] Burby, R.J., Deyle, R.E., Godschalk, D.R. & Olshansky, R.B., Creating hazard resilient communities through land-use planning. *Natural Hazards Review*, **1**(2), pp. 99–106, 2000.
[22] Lynch, K., *The Image of the City*, MIT Press: Cambridge, MA, 1960.
[23] Sepe, M., Adaptive places: achieving resilience, by facing risks. *WIT Transactions on Ecology and the Environment*, vol. 258, WIT Press: Southampton and Boston, pp. 285–295, 2022.
[24] Satterthwaite, D., Cities' contribution to global warming: notes on the allocation of greenhouse gas emissions. *Environment and Urbanization*, **20**(2), pp. 539–549, 2008.
[25] Meerow, S., Newell, J.P. & Stults, M., Defining urban resilience: A review. *Landscape and Urban Planning*, **147**, pp. 38–49, 2016.
[26] Arnstein, S.R., A ladder of citizen participation. *Journal of the American Planning Association*, **35**(4), pp. 216–224, 1969.
[27] Innes, J.E. & Booher, D.E., Reframing public participation: Strategies for the 21st century. *Planning Theory and Practice*, **5**(4), pp. 419–436, 2004.
[28] Pelling, M., *Adaptation to Climate Change: From Resilience to Transformation*, Routledge: London, 2011.
[29] Vale, L.J. & Campanella, T.J., *The Resilient City: How Modern Cities Recover from Disaster*, Oxford University Press: Oxford, 2005.
[30] Campanella, T.J., Urban resilience and the recovery of New Orleans. *Journal of the American Planning Association*, **72**(2), pp. 141–146, 2006.
[31] Walker, B. & Salt, D., *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*, Island Press: Washington, DC, 2006.
[32] Agrawal, A., Dismantling the divide between indigenous and scientific knowledge. *Development and Change*, **26**(3), pp. 413–439, 1995.
[33] Berkes, F., Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management*, **90**(5), pp. 1692–1702, 2009.