

Urban Resilience in Secondary Cities in Low- and Middle-Income Countries: A Multidimensional Spatial Approach

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Abstract:

The rapid pace of urbanization in low- and middle-income countries has increased the importance of secondary cities as intermediary centers connecting rural areas with urban centers and markets. At the same time, these cities have become increasingly exposed to climate-related, economic, health, and logistical disruptions. In this context, the concept of **urban resilience** has emerged as a framework for understanding cities' capacity to maintain their essential functions, respond to disruptions, adapt to their impacts, and restore their functional capacities in the face of multiple crises.

The study draws on the evolution of the concept of urban resilience, from an initial focus on resistance and recovery toward a dynamic, multidimensional approach encompassing adaptation and transformation. It further expands this perspective by considering the city as an interconnected system of economic, social, environmental, institutional, and infrastructure components. The theoretical analysis demonstrates that the resilience of secondary cities cannot be explained by a single factor; rather, it is shaped by the interaction among **economic capacity, social cohesion, infrastructure efficiency, institutional and governance capacity, and environmental capacity to withstand pressures and disruptions**, within spatial relationships that connect the city to its rural and regional surroundings and to broader urban networks.

Accordingly, the study adopts a **multidimensional and spatial approach** to measuring urban resilience, combining the construction of a composite index of its components with an analysis of their spatial distribution. This approach makes it possible to identify strengths, vulnerabilities, and disparities both among and within secondary cities. The framework highlights the need to move beyond approaches that focus primarily on major cities and to develop analytical tools that account for the functional and spatial characteristics of secondary cities, as well as their role in achieving balanced development and strengthening their capacity to withstand, adapt to, and transform in response to changing crises.

Keywords: Urban resilience; secondary cities; low- and middle-income countries; multidimensional resilience; multidimension

Introduction

Over the past decades, the world has witnessed rapid urban transformations that have led to a growing number of people living in cities and an expansion of urban areas, particularly in low- and middle-income countries. Urbanization is no longer confined to the growth of capitals and major cities;

secondary cities have increasingly become a fundamental component of urban transformation, accommodating growing populations and performing important economic, social, and functional roles in connecting rural areas with major urban centers. Owing to their intermediate position, these cities are characterized by strong relationships with their surrounding rural regions and by mutual dependence in the flows of people, goods, resources, and food (Zimmer et al., 2022; Secondary Cities as Catalysts for Nutritious Diets, 2023).

This transformation has increased cities' exposure to a range of interconnected disruptions and pressures, including economic crises, natural disasters, climate change, epidemics, disruptions to transportation, energy, and markets, as well as social and spatial inequalities. These risks are particularly significant in secondary cities in low- and middle-income countries, where rapid urban growth may be accompanied by limited financial and institutional resources, weaknesses in certain infrastructure and service systems, and uneven capacities for planning and crisis response (Bruneau et al., 2003; Cutter et al., 2008).

In this context, the concept of **urban resilience** has emerged as an analytical framework for understanding the capacity of cities and urban systems to cope with multiple shocks and pressures. Resilience does not merely refer to returning to the pre-crisis state; rather, it has increasingly been understood more broadly as the capacity of an urban system to absorb disruptions, maintain its essential functions, respond to changes, learn from them, and undertake the necessary transformations when the existing system can no longer be sustained (Bruneau et al., 2003; Resilience Alliance, 2007).

This perspective is based on viewing the city as a complex system composed of a set of interconnected subsystems, whereby disruptions affecting one system may influence the performance of other systems. Accordingly, urban resilience is not an isolated characteristic of a particular sector, but rather the outcome of interactions among the economic, social, institutional, environmental, and infrastructure dimensions within the urban system (Mou et al., 2020; Cutter et al., 2008).

From this perspective, assessing urban resilience should not be limited to measuring a single condition or indicator; rather, it requires consideration of a set of interconnected dimensions that reflect the city's capacity to maintain continuity and adapt. The literature has evolved from approaches focusing on resistance to shocks and the speed of recovery toward more comprehensive approaches that integrate absorptive capacity, response, adaptation, learning, and transformation. Studies have also distinguished between resilience as a dynamic process that develops before, during, and after a disruption, and resilience as a measurable state at a given point in time (Bruneau et al., 2003; Cutter et al., 2008; Resilience Alliance, 2007).

This development has been reflected in the emergence of various models and indicators for measuring urban resilience, including models focusing on social, economic, institutional, infrastructure, and environmental dimensions, as well as approaches that view the city as an interconnected system of flows and relationships. The **Baseline Resilience Indicators for Communities (BRIC)** model contributed to consolidating the multidimensional indicator-based approach by measuring a range of social, economic, institutional, and infrastructure characteristics associated with communities' capacity to withstand hazards and recover from them (Cutter et al., 2008).

The importance of this approach becomes even more evident when considering **secondary cities in low- and middle-income countries**. These cities are not merely smaller versions of capitals or major

cities; rather, they possess distinctive urban and regional functions. They often serve as intermediary centers for trade, services, employment, and the distribution of agricultural products, connecting producers in rural areas with markets and consumers in urban areas. Consequently, their resilience is strongly related to the resilience of the relationships between the city and its regional area, rather than solely to the capacity of its internal components to cope with shocks (Zimmer et al., 2022; Secondary Cities as Catalysts for Nutritious Diets, 2023).

Among the urban systems most closely associated with these transformations is the **urban food system**. Cities continuously depend on food flows originating from rural, regional, national, and international areas, while the population's ability to access food is influenced by production, transportation, storage, distribution, prices, income, infrastructure, and public policies. Consequently, any disruption occurring at one stage of this system may propagate through networks to other stages, making urban food security an issue that extends beyond the mere availability of food within the administrative boundaries of the city (Haysom & Battersby, 2023; Zurek et al., 2022).

Within this framework, the concept of **urban food resilience** has emerged as an extension of the concept of urban resilience. However, it focuses specifically on the capacity of the food system associated with the city to continue providing sufficient, safe, nutritious, accessible, and equitable food to the population while maintaining its essential functions during and after disruptions and adapting to long-term changes. Accordingly, food resilience does not refer solely to the ability of agricultural production to continue; rather, it encompasses a broad network of functions extending from production to aggregation, storage, transportation, trade, processing, distribution, and consumption, in addition to the institutions, rules, and policies governing these processes (Haysom & Battersby, 2023; Urban Food Resilience, 2025).

This perspective emphasizes the need to move beyond approaches that reduce urban food resilience to **local production or urban agriculture** alone. The literature has shown that the resilience of urban food systems is shaped by the interaction of several elements, including production resilience, supply-chain resilience, transportation, storage, and distribution infrastructure, the economic capacity of populations to access food, spatial equity in its distribution, as well as institutional capacity to respond to crises (Haysom & Battersby, 2023; Zurek et al., 2022; Urban Food Resilience, 2025).

These dimensions are particularly important in secondary cities in low- and middle-income countries because of their intermediate position between rural production and urban consumption. Such cities may serve as key points for the aggregation, storage, marketing, and distribution of agricultural products, while simultaneously representing growing food markets. However, this intermediary function also makes them vulnerable to disruptions in transportation, markets, climate, and agricultural production. Furthermore, limited storage and transportation facilities, organized markets, and logistical services may increase the sensitivity of local food systems to shocks (Zimmer et al., 2022; Secondary Cities as Catalysts for Nutritious Diets, 2023).

The relationship between a secondary city and its surrounding rural area also represents a fundamental element in understanding food resilience. Rather than viewing the city as a closed unit, it can be understood as part of a **City-Region Food System**, within which rural production areas interact with urban markets, transportation and distribution networks, and consumption areas. This perspective provides a more realistic understanding of food and resource flows and helps identify patterns of

dependence, sources of vulnerability, and available alternatives when disruptions occur (Haysom & Battersby, 2023; Zimmer et al., 2022).

Food resilience is not limited to the supply side, as **access to food** constitutes one of its core components. Food may be available in urban markets, yet some neighborhoods or social groups may experience difficulties in accessing it because of low income, high prices, inadequate transportation, distance from markets, or inequalities in the distribution of infrastructure and services. Therefore, assessing food resilience should take into account not only the quantity of food available, but also the economic, spatial, and social capacity of populations to access it (Haysom & Battersby, 2023; Zurek et al., 2022).

This is closely related to the role of **governance and local institutions** in building food resilience. Urban food systems intersect with multiple sectors, including agriculture, trade, transportation, health, the environment, urban planning, and social protection. Consequently, the effectiveness of responses to disruptions depends, in part, on the ability of different institutions to exchange information, coordinate resources, and make integrated decisions. This dimension is particularly important in secondary cities, where responsibilities may be distributed across multiple levels of government and institutional and financial capacities may be more limited than those available in major cities (Resilience Alliance, 2007; Haysom & Battersby, 2023; Urban Food Resilience, 2025).

Accordingly, **urban food resilience in secondary cities** can be viewed as a multidimensional characteristic arising from the interaction among food production capacity, the resilience of supply and distribution chains, population access to food, and institutional and governance capacity. These dimensions do not operate independently. Disruptions in production may lead to disruptions in supply and prices, while inadequate transportation and storage may limit the movement of products to markets. At the same time, rising prices may reduce households' economic capacity to access food even when it remains available in markets (Urban Food Resilience, 2025; Haysom & Battersby, 2023).

From a temporal perspective, resilience should not be confined to the moment when a crisis occurs. Rather, it can be analyzed through interconnected stages encompassing **preparedness and the capacity to withstand disruptions before they occur, response and adaptation during the disruption, and recovery and transformation afterward**. This perspective makes it possible to move from measuring the immediate outcomes of a crisis toward analyzing the underlying capacities that enable the food system to maintain its essential functions and adapt to changing circumstances (Bruneau et al., 2003; Resilience Alliance, 2007; Urban Food Resilience, 2025).

From a spatial perspective, food resilience does not develop at a single level; rather, it extends from the neighborhood level within the city to the city as a whole, and then to the rural and regional areas connected to it. Therefore, the overall urban average may conceal significant disparities in access to food, proximity to markets, infrastructure availability, and the capacity to cope with price increases or supply disruptions. This makes spatial analysis an essential tool for identifying internal disparities, areas of vulnerability, and relative resilience capacity (Cutter et al., 2008; Zimmer et al., 2022; Urban Food Resilience, 2025).

Accordingly, studying food resilience in secondary cities requires a shift from one-dimensional assessment toward **multidimensional measurement and spatial analysis**. Multidimensional measurement enables the construction of a composite index reflecting the interaction of different resilience components, while spatial analysis makes it possible to identify disparities within the city,

detect areas of strength and vulnerability, and relate them to population characteristics, infrastructure, market and transportation networks, and the relationship with surrounding productive areas (Cutter et al., 2008; Urban Food Resilience, 2025; Comparison of Urban Food System Resilience Assessment Frameworks, 2025).

A research gap emerges here, as a significant part of the urban and food-system literature has historically focused on major cities and capitals, while secondary cities have received comparatively less attention, despite their growing role in urbanization and in connecting rural production with urban markets. This does not imply an absence of studies addressing these cities; rather, it points to the need for further research that treats them as urban systems with distinctive functional, spatial, and food-system characteristics, particularly in low- and middle-income countries (Zimmer et al., 2022; Secondary Cities as Catalysts for Nutritious Diets, 2023).

Based on this framework, the study seeks to develop an integrated approach to measuring **urban food resilience in secondary cities**, combining **production resilience, supply-chain resilience, food-access resilience, and institutional and governance capacity**, while taking into account the functional relationship between the city and its rural and regional surroundings. The study also employs spatial analysis to identify internal disparities and determine areas of vulnerability and resilience capacity, thereby moving beyond merely describing the state of the food system toward explaining spatial differences in its capacity to withstand and adapt to disruptions (Haysom & Battersby, 2023; Urban Food Resilience, 2025).

Thus, the study of food resilience in secondary cities does not begin by considering the city as a self-sufficient unit; rather, it conceptualizes the city as an **urban node within a broader network of food, resource, people, and information flows**. This perspective leads to an understanding of resilience as a dynamic, multilevel capacity shaped by the interaction between the city's internal characteristics, its rural and regional linkages, supply networks, institutional capacity, and the social and economic characteristics of its population. Accordingly, measuring this resilience and analyzing its spatial distribution provides an entry point for understanding the extent to which secondary cities in low- and middle-income countries can maintain the continuity of their food systems, reduce the impacts of disruptions, adapt to them, and build more sustainable and equitable pathways for the future (Resilience Alliance, 2007; Zimmer et al., 2022; Urban Food Resilience, 2025).

2. Urban Resilience System

The **urban resilience system** is viewed as a complex and composite system consisting of a set of interconnected subsystems, each of which possesses its own characteristics and capacities for resilience and adaptation (Mou et al., 2020). In this context, **urban resilience assessment** is not limited to measuring the state attained by a city at a particular point in time; rather, it encompasses its capacity to **withstand disruptions and disasters, respond to their impacts, recover from them, and adapt to future changes** (Kahan et al., 2009). Accordingly, urban resilience represents a dynamic process that goes beyond mere recovery after a shock to include the capacity of the urban system to prepare for disruptions, adapt to them, and enhance its capacity to cope with them in the future.

As the challenges facing cities continue to increase, **urban safety and resilience** have become fundamental pillars for achieving sustainable and high-quality urban development. However, resilience levels are not distributed uniformly across cities, as they vary according to their economic, social, and institutional characteristics, levels of development, and development trajectories, as well

as differences in their exposure to risks and pressures. These differences may result in clear spatial variations in cities' capacities to withstand disruptions, recover from them, and adapt to their impacts.

This study therefore seeks to develop an **integrated system of indicators for assessing urban resilience**, enabling resilience to be measured through a set of interconnected dimensions and indicators. The study also employs **spatial analysis using Geographic Information Systems (GIS)**, together with the construction of a **multidimensional urban resilience index**, to identify spatial and temporal variations in resilience levels among cities and analyze the nature of relationships and coordination among the different dimensions constituting urban resilience.

The analysis is not limited to determining the level of resilience; it also extends to diagnosing the factors that constrain its development. The study therefore employs the **Obstacle Degree Model** to identify the dimensions and indicators that contribute most significantly to hindering the development of urban resilience, as well as to reveal weaknesses and deficiencies within the urban system. This analysis makes it possible to identify areas requiring greater attention within policies aimed at **risk reduction and strengthening response and adaptive capacity in the future** (Paganini, 2019).

Accordingly, the findings of the study may provide an analytical basis for supporting urban resilience management and guiding policies and interventions aimed at strengthening cities' capacity to cope with different types of disruptions.

1.2. Conceptual Framework of Urban Resilience

Urban resilience is understood from a systems perspective as an emergent property resulting from the continuous interaction among a set of human, environmental, physical, and institutional components. The city represents an interconnected human–environment system comprising the urban economy, society, institutions, ecosystems, and infrastructure. These components continuously interact in response to various pressures and shocks (Mou et al., 2020). From this perspective, urban resilience refers to the **capacity of a city to withstand disruptions, respond to them, recover from their impacts, adapt to changes, and undertake the necessary transformations to maintain its essential functions and continuity**.

This capacity does not develop independently within a single component of the city; rather, it results from the interaction among various actors, institutions, and spatial levels. Therefore, the participation of **residents, local communities, government institutions, non-governmental organizations, and various stakeholders**, together with coordination among them, is particularly important for building a more integrated urban capacity to cope with risks (Zhao et al., 2021).

Within this framework, the theoretical literature distinguishes between resilience as a **state** and resilience as a **process**. The former is associated with the characteristics of an urban system that enable it to better withstand shocks and maintain its essential functions, whereas the latter concerns the pathway through which the system responds to, recovers from, and adapts to a disruption or transforms in response to changing conditions (Cutter et al., 2008). This means that the assessment of urban resilience should not be confined to measuring a particular level of resilience at a specific point in time; rather, it should take into account the **dynamics of the urban system, the interactions among its components, and changes in its capacities over time**.

This perspective has contributed to the development of multiple frameworks for understanding the components of urban resilience. At an early stage, the **Resilience Alliance** proposed four core components for analyzing resilience in the urban context: **built environment, metabolic flows,**

governance networks, and social dynamics (Resilience Alliance, 2007). The built environment represents the physical foundation upon which urban functions rely and includes facilities, structures, and infrastructure. Metabolic flows refer to the movement of resources, energy, water, food, and other flows that ensure the continuity of the urban system under both normal and exceptional conditions.

Governance networks are related to institutional and organizational capacity to manage the city and coordinate responses to risks, including decision-making mechanisms and cooperation among different actors. **Social dynamics**, meanwhile, reflect the nature of relationships within the urban community, the level of social capital, solidarity, and cooperation among residents, as well as the capacity of institutions and communities to reduce social vulnerabilities and inequalities (Rockefeller, 2018).

These components indicate that urban resilience cannot be reduced to infrastructure or economic capacity alone; rather, it requires consideration of an integrated set of **tangible and intangible components**. These components have been addressed within categories encompassing built facilities and structures, the environment, society, and the economy (Aoki, 2016). Accordingly, assessing urban resilience requires a comprehensive approach that considers the city's physical structure and natural resources, alongside its economic, social, and institutional capacities.

Accordingly, a resilient city can be viewed as an **open, complex, and multidimensional urban system** in which infrastructure, the economy, society, the environment, and governance continuously interact. These dimensions do not operate independently; rather, the overall level of resilience depends on the nature of the relationships and interactions among them, as well as on the capacity of each dimension to support the others or compensate for their deficiencies. From this perspective, measuring urban resilience requires the development of a multidimensional framework capable of capturing these interrelationships and revealing not only the city's overall resilience level, but also **spatial disparities among cities, gaps across resilience dimensions, and the factors that most significantly constrain the development of an urban system capable of withstanding, recovering from, and adapting to shocks**.

Urban Resilience Assessment Indicator System

Based on the previous literature, the conceptual framework adopted in the study, and the nature of the available data, a **multilevel system of urban resilience assessment indicators** was developed. The system consists of five main subsystems representing the core dimensions of resilience: **economy, society, institutions, environment, and infrastructure**.

The system comprises **10 criterion-level indicators and 36 measurable sub-indicators**, allowing the different aspects of urban resilience to be represented quantitatively and systematically.

First: Economic Resilience

This dimension aims to measure the capacity of the urban economy to **withstand economic shocks, maintain the continuity of economic activity, and recover from disruptions**. It focuses primarily on the level of economic development, the diversity of economic activities, and the capacity to provide the resources required for economic recovery and transformation (Bodun, 2015; Yang et al., 2019). This dimension comprises **8 indicators** reflecting a set of economic characteristics associated with the city's capacity to withstand shocks and restore its economic activity.

Second: Social Resilience

This dimension reflects the capacity of the urban community to **cope with disruptions, reduce their impacts on the population, and maintain social cohesion**. It is associated with the level of social equity, demographic characteristics, and residents' ability to access essential resources and services, as well as their capacity to respond to events and disasters (Vallance and Carlton, 2015; Cutter et al., 2008).

This dimension includes **7 indicators** designed to measure the degree of social cohesion and the community's capacity for resistance and recovery.

Third: Institutional Resilience

Institutional resilience refers to the capacity of institutions and governmental and community organizations to **prepare for disruptions, make appropriate decisions, coordinate responses, manage resources during crises, and ensure the continuity of essential functions**. This dimension is particularly important because the effectiveness of crisis response depends not only on material resources but also on the capacity of institutions to coordinate, cooperate, and make decisions (Yang et al., 2019).

This dimension comprises **7 indicators** for measuring institutional and organizational capacities related to risk management and response to disruptions.

Fourth: Environmental/Ecological Resilience

This dimension concerns the capacity of the urban environment and the ecosystems surrounding the city to **absorb environmental pressures, reduce the impacts of hazards, and restore their functions following disruptions**. It also reflects the city's level of preparedness to address environmental risks before they occur and its capacity to recover afterward (Eakina et al., 2017).

This dimension includes a set of indicators measuring environmental characteristics associated with risk preparedness, the capacity to reduce their impacts, and the restoration of environmental functions.

Fifth: Infrastructure Resilience

Infrastructure represents one of the fundamental components of a city's capacity to continue performing its functions during and after crises. Accordingly, this dimension focuses on the capacity of urban infrastructure to **withstand disruptions, reduce losses, ensure the continuity of essential services, and support the recovery process** (Mol et al., 2021).

This dimension comprises **7 indicators**, covering aspects related to municipal infrastructure, in addition to information and communication infrastructure, given its essential role in information exchange, coordination, and response during crises.

Thus, the proposed indicator system provides an integrated framework for measuring urban resilience by combining **economic, social, institutional, environmental, and physical capacities**. The structure of the indicator system also enables a transition from the sub-indicator level to the dimension level and ultimately to a **composite urban resilience index**, thereby allowing comparisons among cities and analyses of spatial and temporal disparities, followed by the use of the Obstacle Degree Model to identify the indicators that contribute most significantly to weakening the level of resilience.

Results

The results of the **Urban Resilience Index assessment** revealed clear disparities in resilience levels among the cities. Cities classified as having **low** and **low-to-medium** levels of resilience accounted

for 33.33% and 28.77% of the total number of cities, respectively, representing a combined share of 62.10%. This indicates that more than half of the cities fell within the relatively lower levels of urban resilience during the study period.

In contrast, the number of cities recording **medium, medium-to-high, and high** levels of urban resilience was 53, 40, and 18 cities, respectively, corresponding to 18.04%, 13.58%, and 6.28% of the total number of cities. These findings reveal the limited prevalence of higher levels of resilience compared with low and medium levels.

Overall, the classification results indicate that urban resilience was characterized by a concentration of the majority of cities around the **medium and low-to-medium levels**, while the proportion of cities with high resilience remained limited. This distribution reflects disparities in the economic, social, institutional, environmental, and infrastructural capacities of cities, which affect their ability to withstand disruptions, recover from them, and adapt to their impacts.

Assessment of the Urban Resilience Index at the Sub-Dimensional Level

The assessment was not limited to the overall urban resilience index; rather, the development of the **sub-dimensions** was also analyzed by calculating a resilience index for each dimension based on the weighted values of its constituent indicators. In addition, the **Coefficient of Variation (CV)** was used to measure the degree of relative variation in resilience levels among the regions during the study period.

The results showed a decline in the coefficient of variation for urban resilience from **0.3482 in 2000 to 0.3206 in 2018**. Within the scope of the indicator used, this decline indicates a reduction in the degree of relative dispersion among cities, suggesting that the development of urban resilience gradually moved toward greater spatial convergence and balance, while notable differences among cities remained.

At the level of the sub-dimensions, four dimensions—**Economic Resilience (Econ. R.)**, **Social Resilience (Soc. R.)**, **Environmental/Ecological Resilience (Ecol. R.)**, and **Infrastructure Resilience (Inf. R.)**—exhibited positive trends consistent with the development of the overall urban resilience index. This indicates that improvements in these dimensions were generally associated with higher levels of urban resilience, although the degree of development varied from one dimension to another.

Infrastructure Resilience was among the dimensions showing the most pronounced changes during the study period. This reflects the increasing importance of infrastructure in supporting cities' capacity to cope with disruptions and maintain the continuity of essential functions and services, as well as its role in accelerating the recovery process following crises.

In contrast, the gap between **Institutional Resilience (Ins. R.)** and the other resilience dimensions gradually widened. This indicates that institutional development did not progress at the same rate as the improvements observed in the economic, social, environmental, and infrastructure dimensions. According to the study findings, this disparity was associated with regional differences in certain institutional indicators, particularly those related to **pension insurance, the household registration system, and the availability of health institutions and services**. These factors contributed to maintaining institutional resilience at a level of imbalance compared with the other dimensions.

These findings highlight the importance of viewing urban resilience as a **multidimensional system**, as a high level in one dimension does not necessarily imply a comparable level of resilience across the

other dimensions. Therefore, the assessment of the overall index should be accompanied by a detailed analysis of its components, since weaknesses in one dimension may constrain the capacity of the urban system as a whole to withstand shocks, recover from them, and adapt to them.

Accordingly, the findings reveal that strengthening **institutional resilience** represents an important area for improving the balance among the dimensions of urban resilience, particularly by addressing disparities in services and institutions, as well as social and health protection mechanisms. The findings also underscore the need to adopt **integrated policies** that do not focus solely on infrastructure or economic growth, but rather work in parallel to develop institutional, social, and environmental capacities, thereby ensuring the development of more balanced and sustainable urban resilience.

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