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Research article

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ASSESSMENT OF COMMUNITY RESILIENCE TO NATURAL DISASTER AND CLIMATE CHANGE RISKS USING THE BRIC FRAMEWORK, CASE STUDY IN HO CHI MINH CITY

Tran Nhat Nguyen [1], Tran Thi Kim [2,3,*], Nguyen Thanh Trung [4], Nguyen Nhu Y [1], Trinh Thi Minh Chau [1]

ABSTRACT

Disaster risk resilience capacity plays a key role in protecting communities and supporting sustainable development. This study applies the Baseline Resilience Indicators for Communities (BRIC) framework to assess the Community Resilience Indicator (CRI) of Ho Chi Minh City. The framework comprises six component groups: Economic, Social, Community, Infrastructure, Environmental, and Institution & Organization, and is operationalized through 42 specific indicators selected in consultation with local departments and experts. Indicator weights were determined using both the AHP (Analytic Hierarchy Process) method and the Iyengar–Sudarshan (1982) approach to ensure objectivity and practicality. The CRI assessment results for wards and communes within the former administrative boundaries of Ho Chi Minh City (prior to July 2025) reveal clear spatial differences. The CRI average is 0.56, with scores ranging from 0.40 in coastal communes, where exposure to climate-related hazards is high, to 0.65 in inner-city wards, which benefit from stronger infrastructure and institutional support. These findings highlight the uneven distribution of resilience across localities and emphasize the varied strengths and vulnerabilities within the city. By combining a systematic framework with context-specific data, this study provides a robust quantitative tool for evaluating community resilience. The CRI offers policymakers an evidence-based foundation for prioritizing investments, allocating resources, and integrating disaster risk reduction into long-term urban planning, especially as Ho Chi Minh City transitions toward becoming a regional megacity.

Key words: Resilience capacity, Natural disaster risk, Climate change, Ho Chi Minh City

[1]*Ho Chi Minh City Institute for Development Studies, 28 Le Quy Don Street, Xuan Hoa Ward, Ho Chi Minh City, Vietnam*

[2]*University of Science, 227 Nguyen Van Cu Street, Cho Quan Ward, Ho Chi Minh City, Vietnam*

[3]*Vietnam National University, Dong Hoa Ward, Ho Chi Minh City, Vietnam*

[4]*Institute for Environment and Resources, 142 To Hien Thanh Street, Dien Hong Ward, Ho Chi Minh City, Vietnam*

Correspondence

Tran Thi Kim, University of Science, 227 Nguyen Van Cu Street, Cho Quan Ward, Ho Chi Minh City, Vietnam

Vietnam National University, Dong Hoa Ward, Ho Chi Minh City, Vietnam

Email: ttkim@hcmus.edu.vn

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INTRODUCTION

Large and densely populated cities in Southeast Asia are increasingly exposed to multiple types of natural disasters, which are becoming more complex and escalating in both frequency and severity due to the impacts of climate change (CC) and rapid urbanization [1–3]. During the rainy season, common disaster events include typhoons, flooding, failure bank, and tornadoes. Typhoons typically bring strong winds and heavy rainfall, causing severe damage to housing, infrastructure, while also disrupting electricity and urban transportation systems [4]. Prolonged heavy rain, combined with inefficient drainage systems, has made flooding a persistent and severe issue in many coastal cities and low-lying urban areas such as Ho Chi Minh City (HCMC), Bangkok, and Jakarta [5–7]. HCMC is a special urban center and serves as the leading economic, cultural, and scientific-technical hub of Vietnam. However, alongside its rapid economic development, HCMC is increasingly facing serious challenges due to the impacts of CC and urban natural disaster risks (NDRs). In this context, resilience has emerged as a critical component of sustainable urban development strategies, particularly in large coastal cities such as HCMC. At the national level, Decision No. 379/QD-TTg by the Prime Minister of Vietnam on the Approval of the National Strategy for Natural Disaster Prevention and Control to 2030, with a Vision to 2050 [8], clearly identifies "enhancing resilience" as one of eight key strategic tasks. Accordingly, HCMC is designated as a priority area that requires enhanced resilience capacity to respond to drought, saltwater intrusion, air pollution, flooding, inundation, and typhoons, particularly urban inundation caused by heavy rainfall and tidal surges, which are increasing in both frequency and intensity. In the international context, the assessment and measurement of community resilience have been extensively developed to provide a scientific basis for policy planning and risk management. One of the widely recognized frameworks is BRIC, developed by Susan Cutter and colleagues, which focuses on six main pillars [9]. Another notable model is the City Resilience Framework (CRF), developed by Arup and the Rock-

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efeller Foundation, which outlines four core areas and twelve pillars to assess the overall resilience of cities [10] . Meanwhile, the UNDRR Resilience Scorecard, developed in alignment with the Sendai Framework for Disaster Risk Reduction, provides an evaluation system for urban governments to assess disaster resilience capacity through ten content areas [11,12] . In addition, regional initiatives such as the Asian Cities Climate Change Resilience Network (ACCCRN) have also developed assessment frameworks appropriate to the context of developing countries in Asia, focusing on institutional flexibility, community adaptive capacity, and the protection of critical infrastructure [13] . Each framework has its own approach and scope of application, but all emphasize the role of adaptability, recovery, and transformation in the face of growing CC. The BRIC model is highly regarded for its ability to standardize data and allow comparisons across different regions, helping to identify the strengths and weaknesses in each locality's resilience capacity [14] . Thanks to its adaptability, BRIC has been widely applied by scholars and policymakers not only in the United States but also adopted in other countries, including urban contexts in both Asia and Europe [14,15] .

Based on the above analyses, this study focuses on assessing the CRI in HCMC in relation to natural disaster and CC risks through the development and application of indicators from the BRIC framework. Indicator weights are determined using the Analytic Hierarchy Process (AHP) and the Iyengar–Sudarshan (1982) method to ensure objectivity and practicality. The novelty of this study lies in developing a detailed and quantitative assessment methodology for community resilience under the BRIC framework in the context of large Southeast Asian cities, which are affected by multiple types of natural disasters including typhoons, flooding, and extreme heat. In the context of administrative restructuring, as HCMC advances toward becoming a regional megacity and a major economic, industrial, service, and logistics hub in Southeast Asia, the issue of strengthening resilience to disaster and CC risks becomes increasingly urgent. It is essential not only to protect the achievements of economic development but also to ensure long-term sustainability. The BRIC framework has been applied in many countries, including those in Asia. However, to date, no comprehensive study has employed BRIC for HCMC—a special metropolis characterized by low elevation, increasing flood pressures, and intensifying CC impacts that threaten both the livelihoods of its residents and the city's economy. The novelty of this study lies not only in applying the BRIC framework but also in refining the indicator set to reflect local data conditions and specific vulnerabilities of HCMC. Furthermore, by comparing resilience indicators down to the ward/commune level, the study provides practical value for strategic disaster risk management and CC adaptation planning in the city. Thus, this research both builds upon an international theoretical framework and adds applied value tailored to the unique context of HCMC.

MATERIALS-METHODS

Study area

HCMC is a riverside and coastal city with low elevation and a dense network of rivers and canals. The city is frequently affected by heavy rainfall, tidal surges, urban flooding, typhoons, tornadoes, extreme heat, saltwater intrusion and riverbank failures [16] . HCMC is classified among the most vulnerable cities globally in the context of CC, particularly facing flood-related risks associated with sea level rise, extreme rainfall, and tidal surges [17] . A report by the World Bank emphasizes that climate adaptation investment is a top priority for HCMC, stating: "Vietnam must mobilize significant resources to protect HCMC, the low-lying coastal areas, and the Mekong Delta from climate change" [18] .

This study was conducted based on surveys and data collected prior to the administrative merger of HCMC; therefore, all assessments and descriptions of community resilience are presented according to the administrative boundaries of the former HCMC area (excluding territories from Binh Duong and Ba Ria–Vung Tau Province) (Fig. 1).

Framework for Measuring Community Resilience Capacity

Selection of the Assessment Framework

According to statistics by Tariq and colleagues (2021) [19] , there are 36 commonly used models for assessing community resilience based on indicator systems. Among these, three models, CDRI, BRIC (Baseline Resilience Indicators for Communities), and CSRI2, are currently the most widely applied. These models typically assess community resilience using six components: economic, social, community, infrastructure, institutional, and environmental. The BRIC indicator framework is one of the most widely used tools for assessing community resilience in research around the world. Christine Camacho and colleagues (2023) [14] reviewed more than 1,200 studies utilizing the BRIC framework to assess community resilience to disasters and other shocks across six continents, with Asia accounting for the largest proportion

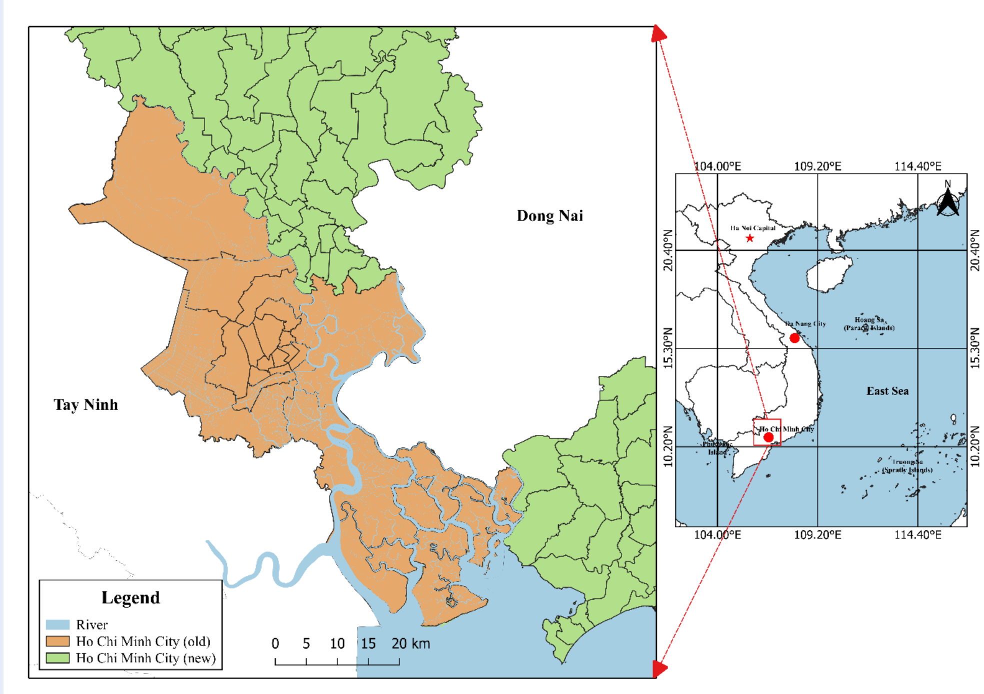

Figure 1: Study area (Source: The base maps and hydrological data provided by the Department of Agriculture and Environment of Ho Chi Minh City, at a scale of 1:275,000)

(59%). BRIC is considered a mature model based on how it has been developed, refined, operated, and validated. The methodological quality of the framework was scored using the OECD framework for composite indicator development, with a median score of 60% (IQR: 40–70%). BRIC[9,20] is a framework for measuring community resilience to natural disasters and CC. It was developed by Susan L. Cutter and colleagues at the University of South Carolina, USA, based on the theoretical foundation of the DROP model (Disaster Resilience of Place)[21] . BRIC aims to quantify and evaluate the baseline resilience capacity of a community (typically at the local level, such as districts or counties) in the face of natural disasters and CC. The BRIC indicator has been widely implemented at both local and regional levels and allows comparisons between localities with different geographic and social characteristics. The BRIC indicator set is well suited to the goals of this study, serving as a tool for managers to compare resilience, plan strategically, and allocate resources effectively.

This study applies the BRIC framework to measure resilience capacity in the face of natural disaster and CC risks in HCMC, with adjustments to the indicator set that reflect local data conditions and the city's specific vulnerabilities. It further provides a detailed assessment at the local level and, based on the calculated results, offers policy recommendations to support strategic climate adaptation planning in HCMC.

Selection of Assessment Indicators

BRIC uses quantitative indicators across six main components to determine resilience capacity, including: (1) Economic: representing local wealth and economic diversification; (2) Social: reflecting demographics, education, and access to healthcare; (3) Community: describing community cohesion, awareness, and local access to information on natural disaster and CC risks; (4) Environmental: indicating the environmental quality of the living area; (5) Infrastructure: referring to the condition of housing, disaster mitigation infrastructure, and the presence of early warning systems; (6) Institution–Organization: assessing institutional capacity, governance structures, financial resources, and human capital related to disaster risk reduction and CC adaptation[14,22] .

According to Joseph F. Hair's (2010) guidelines on multivariate data analysis, each major component should include between five and ten indicators[23] . Therefore, the total number of indicators across the six BRIC components typically ranges from 30 to 60.

Figure 2: Framework and Indicator (Source: Proposed by the authors)

In this study, to establish a basis for proposing the indicator set, the research team referred to both domestic and international studies [14,24,25], while adjusting the selection based on the legal and institutional context of Vietnam. Expert opinions were considered regarding the relevance and feasibility of data collection, to ensure that the proposed evaluation criteria align with HCMC's development priorities under CC conditions. The selected indicators emphasize the following characteristics: (1) Data availability; (2) The ability to quantify the evaluation results; (3) Clarity and practical usability for local authorities to independently conduct future assessments. As a result, the research team selected a total of 42 indicators, as illustrated in Fig. 2.

Sociological Survey and Indicator Normalization

The indicator data were collected from surveys and investigations conducted between September and November 2024; sectoral reports from government agencies, disaster reports in HCMC, statistical yearbooks, and socio-economic development reports covering the period 2015–2024, to ensure consistency with the evaluation cycles of the city's plans, strategies, and resolutions. Meteorological and hydrological data were drawn from established datasets covering 1980–2024, inherited from previous studies. Depending on the specific indicator, values were calculated either as multi-year averages or based on the most recent data available for 2024.

Several indicators related to community composition, awareness and assessment of policy institutions, are quantified through a survey comprising a total of 1,900 samples, targeting three groups: (1) households, (2) business households/ production establishments, and (3) public sector officers, including civil servants and public employees. Data were collected through structured questionnaires administered via face-to-face interviews with the selected respondent groups. The research team applied a stratified sampling method. This was followed by a combination of hierarchical sampling and convenience sampling. Enumerators and research collaborators met each individual on the sampling list to conduct interviews and recorded all responses in the questionnaire forms. The collected indicator values were then organized into a two-dimensional matrix X={Xij} (i= 1, 2...m; j = 1, 2...k), where m represents the number of wards assessed and k is the number of indicators. Since the parameters and indicators collected have different dimensions, they must be normalized before being used in any relational function. This study uses the Human Development Index (HDI) normalization method proposed by UNDP (2006) to standardize the values into a permissible range from 0 to 1 [26]. In this process, the correlation between parameters must be clearly defined. The indicators after normalization all have values ranging from 0 to 1.

Determining the importance level of criteria through weights

To calculate weights that depend on the distribution of component variables, the method proposed by Iyengar - Sudarshan in 1982 [27] and the Analytic Hierarchy Process (AHP) method [28] are commonly used. Among them, the AHP method was applied to calculate for the main components (6 variables) and the Iyengar - Sudarshan (1982) method for 42 sub-criteria to leverage the strengths and offset the limitations of each approach. The AHP method incorporates the practical roles of variables and components in the criteria based on expert opinion analysis (suitable for a small number of variables), while the Iyengar-Sudarshan (1982) method is objective according to statistical data, which makes it convenient for calculating weights involving many variables and multiple components.

AHP Method

The AHP method is a structured decision-making technique that enables the ranking of alternatives and the identification of the most appropriate final weight (weight) [28]. The process begins with the construction of a hierarchical model, followed by pairwise comparisons of criteria at each level, from main to sub-components. The comparison results at each level are weights (importance levels). An expert questionnaire was developed to evaluate the criteria across the six main components of the BRIC framework. The research team conducted consultations with ten experts in the fields of environmental science and urban management, including both government officials and academic researchers.

Iyengar and Sudarshan (1982 Method

The Iyengar and Sudarshan (1982) method is a data-driven approach that performs well in contexts where statistical data are available and involves a large number of variables. Weights are assigned to each indicator based on its degree of dispersion across analysis units (e.g., provinces or districts), following the principle that indicators with higher variability contribute more to overall differentiation and thus receive greater weight [27]. This is one of the techniques for normalizing and assigning weights to component indicators in building a composite indicator.

Determining resilience capacity

After determining the weights, the value of each component assessing the resilience capacity at each study region is quantified according to (Eq. 1):

$$CRI_i = \sum_{j=1}^{K} w_j X_{ij} \quad (1)$$

Where,

CRI_i is the resilience capacity evaluation value of region i;

w_j is the weight for indicator j, $0 < w_j < 1$;

The CRI indicator value serves as a basis for developing zoning maps to categorize regional resilience capacity. According to many experts' assessments, the classification of the probability distribution function of CRI_i can be approximated by several pre-calculated distribution functions such as the Kritxki – Menkel distribution, the Gamma function, or simply by the average line through points of empirical frequency. Accordingly, this study adopts a uniform distribution-based classification into five levels: Very Low, Low, Moderate, High, and Very High, as presented in Table 1.

The results derived from the BRIC model were validated using historical data on disaster events and associated local damages. Areas with lower CRI scores were found to have experienced greater losses in the past, with a clear correlation between CRI values and resilience-related variables such as economic conditions and post-disaster recovery capacity. In addition, a sensitivity analysis was conducted by altering normalization methods and weighting schemes, which confirmed the robustness and stability of the results.

[Source: IPCC (2014) [29]]

Table 1: Classification of the Climate Resilience Indicator

Very low	Low	Moderate	High	Very high
0 < CRI ≤ 0.2	0.2 < CRI ≤ 0.4	0.4 < CRI ≤ 0.6	0.6 < CRI ≤ 0.8	0.8 < CRI ≤ 1.0

RESULTS

Weights of the indicator set

The weights of the main criteria represent their contribution levels to the composite resilience capacity indicator. The calculation results by the AHP method show that among the 6 main indicators, the Infrastructure related to disaster prevention and CC adaptation, is considered the most critical (contributing 25.2%), followed by the Institution - Organization component (24.4%). The third most important indicators is the Economic component (16.0%), followed respectively by Community (14.2%), Environmental (10.4%), and Social (9.8%).

Weights of the sub-indicators, calculated using the Iyengar and Sudarshan (1982) method after data collection, are illustrated in Fig. 3.

3.2 Assessment of resilience capacity to natural disaster and CC risks in HCMC (before the merger date July 2025)

Prior to the administrative merger in July 2025, HCMC comprised 22 districts, county-level towns, and cities, encompassing 102 wards and communes, as defined in Resolution No. 1685/NQ-UBTVQH15 dated June 16, 2025, issued by the National Assembly Standing Committee regarding the reorganization of commune-level administrative units in HCMC. The following analyses are based on the 102 Wards/Communes in the old territory of HCMC (not including the newly incorporated areas of Binh Duong and Ba Ria - Vung Tau).

Community resilience of indicators

The calculation results for each main indicator show values ranging from 0.38 to 0.73. Among them, the 'Social' indicator—reflecting population status, education, and access to healthcare, has the lowest score, while the 'Environmental' indicator, representing the quality of the living environment, records the highest score. Component-wise analysis of the CRI across localities reveals distinct resilience profiles, highlighting both comparative advantages and limitations. This serves as the foundation for proposing solutions to

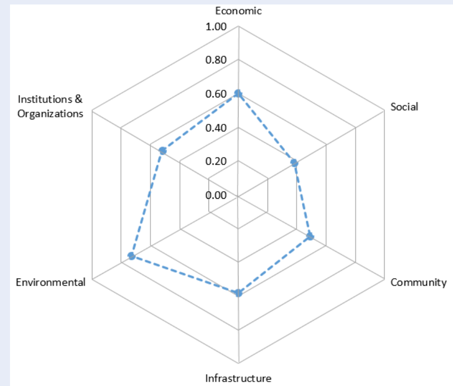

Figure 4: Indicators of the main components (Source: Calculated by the authors)

enhance strengths and overcome weaknesses specific to each locality (Fig. 4).

The calculation results in Figure 5 show that the core central area of the City (Saigon Ward, Tan Dinh, Ben Thanh, Cau Ong Lanh, Ban Co, Xuan Hoa, Nhieu Loc, Vuon Lai, Dien Hong, Hoa Hung) achieves the highest "Economic" indicator score (0.69 – 0.97) because this area concentrates many government agencies, foreign consulates, representative offices of foreign organizations, headquarters and representative offices of domestic and international corporations and companies, with advantages in developing trade, services, and tourism, significantly contributing to the City's GRDP and total state budget revenue (Fig. 5b). The indicator underscores strong economic activities and job opportunities in the City center. At the same time, this area also has the highest "Environmental" indicator values (Fig. 5d).

Meanwhile, in rural areas, the "Economic" indicator (Fig. 5b) score is very low, especially in coastal localities. However, in these economically disadvantaged areas, components such as "Community" and "Institution & Organization" indicators are notably high (Fig. 5d and Fig. 5f), making significant contributions to the overall composite resilience indicator. Typical examples include: Binh Khanh, An Thoi Dong, Can Gio and Thanh An communes – coastal areas affected by natural disaster and CC risks in HCMC, with an "Economic" indicator only at 0.03 (lowest), "Environmental" indicator at 0.45 (lowest) but "Community" indicator at 0.82 (second highest) and "Institution & Organization" indicator at 0.69 (second highest). These results suggest that local authorities in these areas have prioritized institutional arrangements and human resource development for disaster risk reduction and CC adaptation. Residents have

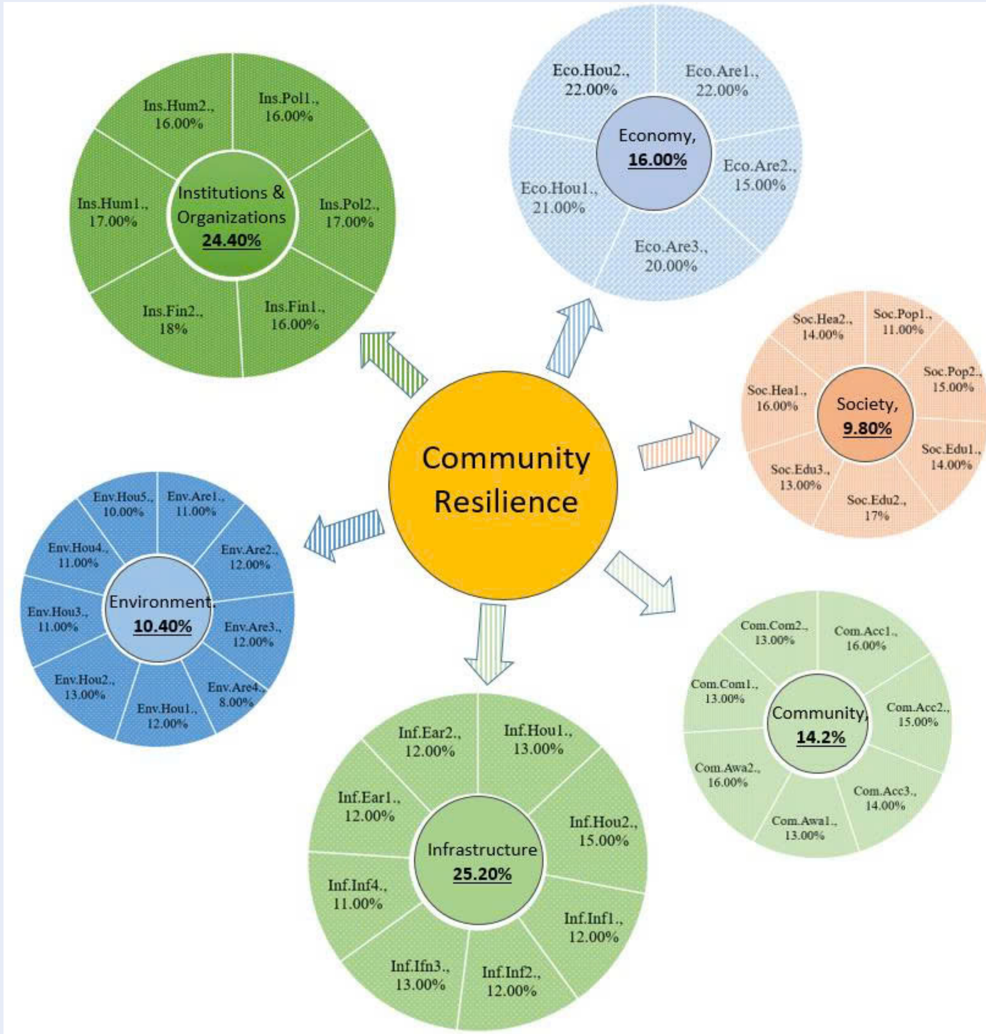

Figure 3: Weights of the main indicators and sub-indicators calculated by the AHP method and Iyengar and Sudarshan (1982) (Source: Calculated by the authors)

actively participated in local training programs and workshops, leading to high levels of awareness, timely access to early warnings, and proactive implementation of risk mitigation measures.

Regarding the "Social" indicator, areas with high scores include Cho Quan, An Dong, Dien Hong wards and eastern city areas such as Hiep Binh, Thu Duc, Tam Binh, Linh Xuan, Tang Nhon Phu. These areas benefit from a high concentration of hospitals and educational institutions, along with a large proportion of the working-age population (Fig. 5c).

For the "Infrastructure" indicator, Tan Thuan, Phu Thuan, Tan My, Tan Hung wards have the highest scores (at 0.73), attributed to a high proportion of durable housing, availability of disaster prevention equipment, warning signage, and designated safe shelters for emergencies (Fig. 5e).

Community resilience index in HCMC

The average CRI score across areas in HCMC is 0.55, with a range from 0.40 (including 4 communes: Binh Khanh, An Thoi Dong, Can Gio, Thanh An) to 0.65 (including 3 wards: Vuon Lai, Dien Hong, Hoa Hung) (Fig. 5a). The detailed CRI calculation results are presented in Table 2.

Variations in geographic location and socio-economic conditions are clearly reflected in the CRI scores, revealing a marked disparity between urban and rural areas. Rural areas (including 17 communes) exhibit the lowest scores, ranging from 0.40 to 0.52, among which coastal areas have the lowest score (0.40), and the highest scores belong to 4 communes in the northwest area of HCMC (including: An Nhon Tay, Thai My, Nhuan Duc, Tan An Hoi, Cu Chi, Phu Hoa Dong, and Binh My). The highest CRI scores are concentrated in the central urban districts, characterized by diversified economies, effective governance, and reduced exposure to natural hazards such as typhoons, bank erosion, and salinity intrusion.

[Source: Calculated by the authors]

The findings indicate that central urban areas exhibit higher resilience, primarily driven by economic diversification and robust healthcare and education systems, which together offer strong financial and social buffers against disaster impacts. By contrast, rural and coastal areas exhibit limited economic capacity and weaker infrastructure; however, these deficiencies are partially mitigated by strong community cohesion and proactive local governance. Adverse environmental conditions, including frequent flooding, salinity intrusion, and substandard housing, further intensify vulnerabilities in peri-urban and coastal regions. These findings suggest that resilience is influenced not only by financial resources and infrastructure quality but also by governance effectiveness and the strength of local social capital. Accordingly, socioeconomic conditions, infrastructure quality, community cohesion, and governance capacity emerge as the fundamental determinants of disparities in CRI.

DISCUSSION

This study demonstrates the applicability of the BRIC framework in the context of a rapidly urbanizing megacity like HCMC. The findings reveal significant disparities in resilience capacity between central urban areas and peri-urban/rural regions, thereby underscoring the importance of spatial factors in resilience theory. The observation that strong social capital and effective local governance can offset limitations in economic and infrastructural resources provides additional empirical evidence for community-based resilience theories. Methodologically, the integration of AHP and Iyengar–Sudarshan weighting approaches offers a balanced mechanism that combines expert judgment with statistical objectivity, thus overcoming the shortcomings of relying on either method alone. Therefore, beyond its policy implications, this study contributes to the scientific foundation for developing and refining resilience measurement frameworks in the increasingly complex context of CC in megacities such as HCMC.

Many studies in the Southeast Asia region have identified a pronounced gap in resilience capacity between urban and rural areas, especially in the context of increasing risks from natural disasters and CC. The ASEAN report (2024) highlights a clear disparity in resilience levels between central urban areas and suburban, rural, and coastal regions across several ASEAN member countries such as Indonesia, the Philippines, Thailand, and Vietnam. In suburban and rural areas of Myanmar and the Philippines, assessment results recorded much higher risk levels due to sea-level rise and typhoons, coupled with limited access to financial services or evacuation plans when compared to urban populations. Similarly, in suburban areas of Vietnam and Thailand, rapid urban expansion without corresponding investments in adaptive infrastructure has heightened vulnerability relative to central urban areas [30]. This neglect of suburban regions contributes to reduced resilience capacity and prolonged recovery periods following disasters. In cities like Jakarta, Manila, or HCMC, public-private partnership projects often focus on middle-class and wealthy residential areas, while slums and low-income residents still lack access to clean water infrastructure, resulting in critically low resilience capacity [31] .

Related studies also emphasize that enhancing resilience capacity for sub-urban areas in HCMC and other ASEAN countries requires a comprehensive strategy that integrates adaptive planning, infrastructure investment, strengthening local governance, promoting community participation, and effectively leveraging international resources. Key approaches include fostering multi-stakeholder collaboration, utilizing digital data and technologies, and promoting spatial equity to enhance the resilience of suburban communities in the context of rapid urbanization and CC adaptation. Recent resilience research in HCMC highlights the urgent need of narrowing the resilience gap between sub-urban and urban areas. Many studies have emphasized the critical task of integrating climate adaptation into suburban development planning, as exemplified by cities like Semarang (Indonesia) and Naga (Philippines), aiming to reduce risks for poor sub-urban populations [32–34] . Additionally, investments in essential infrastructure such as drainage systems, resilient housing, and clean water supply are urgent solutions, as demonstrated by the clean water project in HCMC [35] . Moreover, the application of technology and spatial risk mapping helps identify hotspots of different natural hazards and integrates these tools into apps to support sub-urban residents in taking proactive risk-reduction measures [36–40] . These tasks need to be implemented in a synchronized manner to effectively narrow the resilience gap between the urban core and sub-urban areas in HCMC as well as in other major ASEAN cities.

Table 2: CRI indicators in HCMC

No	Ward/Commune	Area / Region	Resilience Capacity Index
1	Vuon Lai, Dien Hong, Hoa Hung	Urban	0.65
2	An Lac, Binh Tan, Tan Tao, Binh Tri Dong, Binh Hung Hoa	Urban	0.64
3	Hanh Thong, An Nhon, Go Vap, An Hoi Dong, Thong Tay Hoi, An Hoi Tay	Urban	0.62
4	Tan Son Hoa, Tan Son Nhat, Tan Hoa, Bay Hien, Tan Binh, Tan Son	Urban	0.61
5	Cho Quan, An Dong, Cho Lon, Binh Tay, Binh Tien, Binh Phu, Phu Lam	Urban	0.59
6	Tan Thuan, Phu Thuan, Tan My, Tan Hung, Chanh Hung, Phu Dinh, Binh Dong, Tay Thanh, Tan Son Nhi, Phu Tho Hoa, Tan Phu, Phu Thanh	Urban	0.58
7	Hiep Binh, Thu Duc, Tam Binh, Linh Xuan, Tang Nhon Phu, Long Binh, Long Phuoc, Long Truong, Cat Lai, Binh Trung, Phuoc Long, An Khanh	Urban	0.57
8	Sai Gon, Tan Dinh, Ben Thanh, Cau Ong Lanh, Ban Co, Xuan Hoa, Nhieu Loc	Urban	0.56
9	Xom Chieu, Khanh Hoi, Vinh Hoi, Minh Phung, Binh Thoi, Hoa Binh, Phu Tho, Dong Hung Thuan, Trung My Tay, Tan Thoi Hiep, Thoi An, An Phu Dong	Urban	0.55
10	Gia Dinh, Binh Thanh, Binh Loi Trung, Thanh My Tay, Binh Quoi	Urban	0.53
11	An Nhon Tay, Thai My, Nhuan Duc, Tan An Hoi, Cu Chi, Phu Hoa Dong, and Binh My	Rural	0.52
12	Duc Nhuan, Cau Kieu, and Phu Nhuan	Urban	0.50
13	Vinh Loc, Tan Vinh Loc, Binh Loi, Tan Nhut, Binh Chanh, Hung Long, Binh Hung	Rural	0.49
14	Nha Be, Hiep Phuoc	Rural	0.48
15	Hoc Mon, Xuan Thoi Son, Ba Diem, Dong Thanh	Rural	0.46
16	Binh Khanh, An Thoi Dong, Can Gio, Thanh An	Rural	0.40

CONCLUSION

This study developed and applied a community resilience measurement indicator framework for HCMC under the risks of natural disasters and CC, based on the BRIC framework combined with AHP and Iyengar–Sudarshan (1982) weighting methods. The results show that resilience capacity varies significantly across spatial locations and indicator components, reflecting the economic-social characteristics, topography, and infrastructure investment levels of each area. Developed urban centers exhibit higher resilience scores compared to coastal and suburban areas.

The Economic component shows strong performance in central wards characterized by diversified economic activities, but remains very low in coastal communes such as Can Gio, where limited livelihoods increase vulnerability to storms and tidal surges. The Social component reflects unequal access to education, healthcare, and social services - yielding higher scores in urban districts, while limited access in peri-urban and rural areas constrains adaptive capacity to heavy rainfall and flooding. The infrastructure component, which carries the highest weight, reveals the stark contrast between well-equipped urban wards that benefit from solid housing, drainage systems, and shelters, and low-lying areas, where poor drainage and fragile housing structures exacerbate urban flooding and bank failures. The Environmental component highlights increasing pressure from tidal surges, erosion, and flooding. While central wards perform well in this aspect, coastal zones continue to exhibit critical weaknesses in environmental resilience. Notably, in certain rural communes, despite limited economic conditions, high scores in "Community" and "Institution & Organization" components highlight the important role of community participation and proactive local governance in disaster risk reduction. The development of resilience zoning maps enables the identification of priority areas for support, thereby enhancing the effectiveness of policy formulation and resource allocation. This study

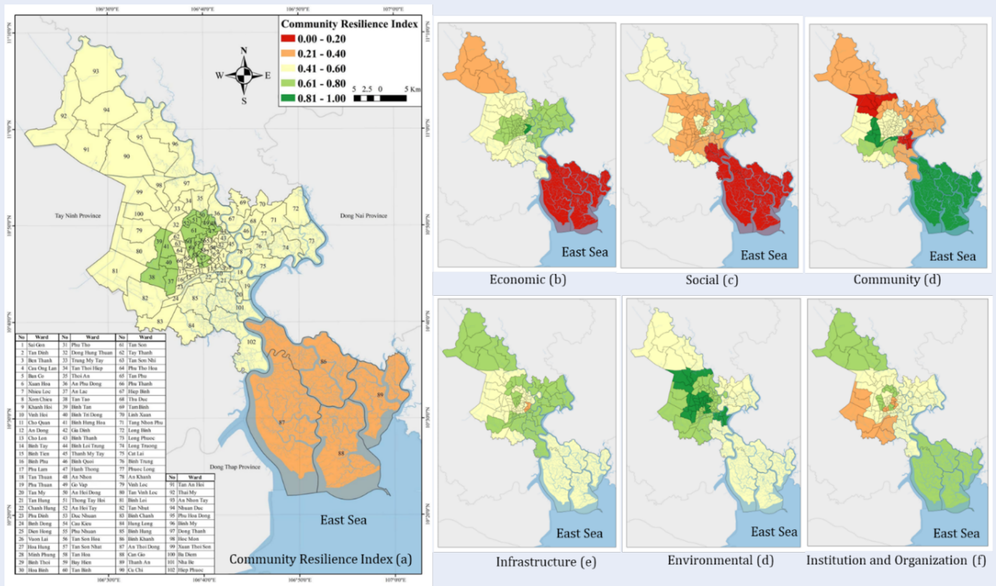

Figure 5: Resilience capacity CRI (2) and capacity by main indicators: Economic (b), Social (c), Community (d), Infrastructure (e), Environmental (d), and Institutions & Organizations (f) (Source: The thematic layer was developed by the authors based on base maps and hydrological data provided by the Department of Agriculture and Environment of Ho Chi Minh City, at a scale of 1:275,000)

also demonstrates that quantitative resilience indicators can provide a comprehensive and objective view of resilience capacity, effectively supporting disaster risk management in the increasingly complex context of CC. As HCMC transitions toward a mega-urban region model following recent administrative mergers, enhancing resilience capacity is not only an urgent environmental and social welfare requirement but also a strategic factor ensuring sustainable long-term development.

Alongside its contributions, this study has several limitations, particularly concerning data availability in HCMC. Difficulties in data collection at both citywide and ward/commune levels may have constrained the ability of certain indicators to fully capture all relevant dimensions of resilience. In addition, resource constraints during the quantitative survey may have affected the representativeness of the sample and introduced potential biases. Moreover, the analysis in this study was conducted within a static time frame, which does not reflect changes in resilience capacity over time. Future research should expand the sampling scope, integrate qualitative data, and apply dynamic analytical approaches to provide a more comprehensive understanding of resilience dynamics in the context of rapid urbanization and CC.

AUTHORS CONTRIBUTIONS

Tran Nhat Nguyen (T.N.N.): Contributed to the conceptualization and methodology of the study; data validation; formal analysis; original draft preparation; review and editing; visualization.

Tran Thi Kim (T.T.K.): Contributed to the conceptualization and methodology of the study; original draft preparation; review and editing.

Nguyen Thanh Trung (N.T.T.): Contributed to data validation and formal analysis.

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CONFLICT OF INTEREST

The authors declare no competing interests.

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Bài báo nghiên cứu

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NGHIÊN CỨU ĐÁNH GIÁ KHẢ NĂNG CHỐNG CHỊU CỦA CỘNG ĐỒNG TRƯỚC RỦI RO THIÊN TAI VÀ BIẾN ĐỔI KHÍ HẬU THEO KHUNG BRIC: TRƯỜNG HỢP THÀNH PHỐ HỒ CHÍ MINH

Trần Nhật Nguyên [1], Trần Thị Kim [2,3], Nguyễn Thanh Trung [4], Nguyễn Như Ý [1], Trịnh Thị Minh Châu [1]

TÓM TẮT

Khả năng chống chịu trước rủi ro thiên tai đóng vai trò quan trọng trong việc bảo vệ cộng đồng và thúc đẩy sự phát triển bền vững. Bài báo này trình bày kết quả đánh giá năng lực chống chịu của cộng đồng (CRI) tại Thành phố Hồ Chí Minh trước rủi ro thiên tai và biến đổi khí hậu (RRTT & BĐKH), thông qua xây dựng và ứng dụng bộ chỉ số dựa trên khung BRIC (Baseline Resilience Indicators for Communities). Dựa vào 6 nhóm thành phần chính – kinh tế, xã hội, cộng đồng, cơ sở hạ tầng, môi trường và thể chế – tổ chức, nghiên cứu này đã lựa chọn 42 chỉ số cụ thể dựa trên dựa trên tổng quan nghiên, điều chỉnh dựa trên cơ sở pháp lý và mức độ sẵn có của dữ liệu để thu thập. Để xác định tầm quan trọng của các chỉ số, nghiên cứu này áp dụng hai phương pháp xác định trọng số là AHP (phân tích thứ bậc) và Iyengar – Sudarshan (1982) để bảo đảm tính khách quan và thực tiễn. Kết quả đánh giá năng lực chống chịu của các phường/xã trên địa phận TPHCM cũ (trước thời điểm sáp nhập tháng 7/2025) cho thấy sự khác biệt rõ rệt theo không gian. Điểm CRI (dao động từ 0 – 1) trung bình của TPHCM là 0.56, dao động từ 0.40 ở các xã ven biển đến 0.65 ở các phường nội đô. Kết quả này phản ánh sự phân bố không đồng đều về khả năng chống chịu giữa các khu vực, đồng thời cho thấy rõ điểm mạnh, điểm yếu của các địa phương về năng lực chống chịu. Bằng việc kết hợp một khung đánh giá có hệ thống với dữ liệu phù hợp với bối cảnh địa phương, nghiên cứu này cung cấp một công cụ định lượng toàn diện để đánh giá năng lực chống chịu. Chỉ số CRI là cơ sở khoa học giúp các nhà hoạch định chính sách ưu tiên đầu tư, phân bổ nguồn lực và lồng ghép giảm nhẹ rủi ro thiên tai vào quy hoạch đô thị dài hạn, đặc biệt trong bối cảnh Thành phố Hồ Chí Minh đang hướng tới vai trò một siêu đô thị vùng.

Từ khoá: Khả năng chống chịu, rủi ro thiên tai, biến đổi khí hậu, Thành phố Hồ Chí Minh

[1]*Viện Nghiên cứu Phát triển Thành phố Hồ Chí Minh, 28 Lê Quý Đôn, Phường Xuân Hòa, Thành phố Hồ Chí Minh, Việt Nam*

[2]*Trường Đại học Khoa học Tự nhiên, 227 Nguyễn Văn Cừ, Phường Chợ Quán, Thành phố Hồ Chí Minh, Việt Nam*

[3]*Đại học Quốc gia Thành phố Hồ Chí Minh, Phường Đông Hòa, Thành phố Hồ Chí Minh, Việt Nam*

[4]*Viện Môi trường và Tài nguyên, 142 Tô Hiến Thành, Phường Diên Hồng, Thành phố Hồ Chí Minh, Việt Nam*

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