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The role of risk mitigation and adaptation measures in climate resilience: A case study of Ho Chi Minh City in Vietnam

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ABSTRACT

Urban flooding poses a major threat to rapidly developing cities, particularly in emerging economies where climate change and urbanization complicate policy planning. The flood vulnerability of Ho Chi Minh City (HCMC) in Vietnam is high due to its low-lying topography, high population density, and inadequate flood infrastructure. This study applies the Institutional Analysis and Development framework (IAD) developed by Polski and Ostrom (1999) to assess climate resilience related to HCMC's flood mitigation and adaptation measures. By considering exogenous variables, action arena, and policy outcomes in the IAD, a systematic evaluation of institutional effectiveness was carried out regarding flood management and long-term resilience. Findings revealed pronounced urban-rural disparities in flood resilience in HCMC. While urban districts benefit from large-scale mitigation measures, rapid urban expansion has outpaced infrastructure development, resulting in persistent vulnerabilities in newly urbanized districts. Adaptation measures, including community-led programs, early warning systems, and zoning regulations, remain underdeveloped, especially in rural and peri-urban districts, where financial and institutional support is limited. Key policy gaps identified from the analysis include multi-level governance coordination, financial sustainability, and the integration of local adaptation efforts into formal planning frameworks. To strengthen climate resilience in HCMC, this study advocates for an adaptive flood resilience strategy that prioritizes (1) multi-level governance coordination to bridge the gaps between national and local policies, (2) financial sustainability mechanisms such as public-private partnerships with long-term investment, and (3) data-driven adaptive strategies to enhance predictive flood modeling and decision making. By identifying institutional barriers and policy limitations, this study sheds light on ways to improve urban flood resilience and offers insights that can be applied to other rapidly urbanizing cities.

Key words: Climate Change, Climate Change Risk, Urban Flooding, Urbanization, Flood Resilience, Vulnerability, Adaptation, Mitigation, Institutional Analysis and Development (IAD) Framework

1. Introduction

With the rapid influx of population moving into urban areas, cities worldwide have recognized urban flooding as a policy challenge. This is especially pertinent in cities of developing countries that face burdens exacerbated by climate change and inadequate infrastructure development (Huong and Pathirana, 2013). The impacts of urban flooding are also multifaceted, ranging from economic losses and threats to public health. Climate change heightens such risks by influencing precipitation patterns, intensifying extreme weather events, and rising sea levels, thereby increasing the frequency and severity of flooding (IPCC, 2023). Moreover, coupled with poor infrastructure and unplanned urbanization, cities are particularly vulnerable to such climate-driven hazards.

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In response, city governments have implemented various mitigation or adaptation interventions to achieve urban flood resilience. Prashar et al. (2023) define the concept of urban flood resilience as the ability to "[live] with a flood," emphasizing the city's capacity to adapt and cope with the impacts of flooding. While mitigation is often referred to as the mitigation of greenhouse gases to reduce long-term climate impacts (Pielke, 1998), the term is used to refer to the efforts aimed at addressing the impact of floods in the context of urbanization and climate resilience. These efforts include infrastructure improvements such as drainage systems, sustainable infrastructure solutions like permeable pavements. Policy interventions can also be used as precautionary measures through land-use planning and zoning regulations (Dharmarathne et al., 2024).

On the other hand, adaptation strategies are considered more appropriate to be applied at the local level, where the direct impacts of climate change could occur differently compared to the national level (Laukkonen et al., 2009). Adaptation focuses more on long-term intervention rather than interventions with shorter time frames. For example, it may prioritize the enhancement of the ability of communities and infrastructure to cope with and recover from flooding events once they happen (Laukkonen et al., 2009). Some examples include emergency response systems and community-based early warning programs, such as climate-resilient urban planning measures (Yoon and Lee, 2024).

While both mitigation and adaptation play critical roles in climate resilience, the effectiveness of such measures varies depending on social contexts (Bengtsson et al., 2007). At the local level, this refers to differences in governance structure and socioeconomic inequalities within urban populations (Rasch, 2017; Roldán-Valcarce et al. 2023). In this study, climate resilience refers to the ability of the city's governance structures, urban systems, and communities to adapt to and recover from climate-induced urban flooding while fostering long-term sustainability (Rezvani et al., 2023). Unlike climate adaptation that focuses on specific adjustments to reduce vulnerability to flooding, climate resilience constitutes the broader institutional, socioeconomic and governance dynamics that influence the city's long-term ability to adapt to future flood risks. Therefore, understanding these complexities is crucial to developing a context-specific and tailored flood risk mitigation strategy.

Vietnam is known for its exposure to climate change not only because of its low-lying topography but also because of its varied socioeconomic conditions (Truong et al., 2022). Ho Chi Minh City (HCMC), Vietnam's economic hub and the most populous city faces grave challenges of urban flooding; spanning 19 urban distracts and five rural districts, the city's 8 million residents are increasingly vulnerable to flood-related risks (Ngoc et al., 2016). HCMC's tropical climate significantly contributes to its flood vulnerability; city residents experience an average annual temperature of approximately 27 degrees Celsius and frequent precipitation events. These environmental factors exacerbate the challenges faced by residents, who are already exposed to societal issues; the high population density puts pressure on urban systems, while outdated drainage infrastructure struggles to cope with intense rainfall. This combination of climatic conditions and urban characteristics creates a complex vulnerability landscape. Despite investments in flood mitigation infrastructure and prioritization of urban flooding in national policies (Ngoc et al., 2016), the increased severity of flooding in the city has led to alarming instances of urban flooding. Consequently, residents have faced property damage, severe health risks, and social displacement (Duy et al., 2018). Moreover, HCMC's different economic zones and commercial districts complicate effective flood risk management strategies. Although several flood mitigation measures exist, there remains a significant gap in the efficacy of these measures. Existing research suggests that the effectiveness has been inconsistent across measures (Downes and Storch, 2014; Scussolini et al., 2017). This underscores the need for more detailed assessment of flood resilience measures in HCMC.

Consequently, this study applies the Institutional Analysis and Development (IAD) framework, proposed by Polski and Ostrom (1999), to evaluate the effectiveness of

flood mitigation and adaptation measures in HCMC. The framework will be used to conduct a resilience assessment on existing climate mitigation and adaptation measures for urban flood risks in HCMC. The IAD is particularly useful for analyzing multi-stakeholder governance structures, institutional coordination, and financial sustainability, all of which are key factors influencing urban flood resilience in rapidly urbanizing cities like HCMC. By examining exogenous variables (socio-economic factors, governance structures, and climate risks), the action arena (e.g., interactions between governmental agencies, international organizations, local communities), and policy outcomes, this study aims to identify institutional barriers and opportunities for strengthening climate resilience in HCMC.

Previous applications of the IAD in flood governance research highlight its significance in evaluating institutional responses to climate-induced urban flooding. For example, Vitale and Meijerink (2023) applied the IAD to analyze flood governance in Italy, revealing how fragmented governance and historical path dependencies impede resilience efforts. Similarly, studies on flood risk governance in the Netherlands (Molenveld and Buuren, 2019) show how the IAD can identify institutional barriers and suggest adaptive governance strategies. Building on these insights, the present study uses the IAD to examine how institutional coordination, financial sustainability, and community participation influence HCMC's flood resilience measures.

The remainder of the paper is organized as follows. The next section provides a review of recent findings on climate resilience and urban flooding mitigation and adaptation efforts, globally and in Vietnam. Then, we describe the IAD used to analyze the case of HCMC. The following section presents the results and implications of the findings. The last section concludes with recommendations and limitations of this paper.

2. Urban Flood Risks and Climate Resilience

2.1. Global Flood Governance Research

Previous research has delved into the complexity of urban flood risks and climate change. At the macro level, urban flood risks are linked to the presence of assets and the access to such resources to residents. In the case of two cities in France, Orléans and Château, several networks—the power grid, internet, pipelines, and roads—were used to evaluate the vulnerability to increased flood risk through a geographical information systems-based approach (Lhomme et al., 2013). Based on their analysis, Lhomme et al. suggest that relatively unprotected or marginalized areas could be identified and compare whether each city's climate adaption strategies were sufficient to enhance resilience. Moreover, Abdrabo and Hassaan (2015) emphasize the need to incorporate 'socioeconomic, physical, environmental, institutional and climate change hazard aspects' beyond the response to the rapid onset of disasters in the context of sea level rise in the Nile Delta. While such conceptual analysis signifies the importance of an integrated framework, the complexities involved in the lack of spatially disaggregated data limit the applicability and precision of resilience assessment.

Beyond a city's assets, another dimension to account for is the time it takes for interaction among 'discursive, institutional, and contextual factors' for policies to evolve and transform (Vitale and Meijerink, 2023) and contribute to sound flood risk management policies. In the context of cities in Italy, authors report that top-down governance and limited non-structural measures hindered the effective adoption of standards imposed on hydraulic infrastructure and even more inclusive policies that utilized spatial planning and community involvement. By applying the IAD, the authors highlight how enduring path dependence in Italian flood risk policies collectively impedes the transition to a more holistic, risk-based flood management paradigm. Hence, Vitale and Meijerink (2023) highlight the necessity for adaptive governance and the inclusion of

diverse, bottom-up initiatives to overcome potential barriers to enhance resilience against future urban flood risks.

2.2. Urban Flooding Mitigation and Adaptation Measures in HCMC and Vietnam

In the case of cities in Vietnam, scholars have primarily analyzed how climate change will affect the city, especially considering the city's rapid urbanization and socioeconomic factors. Exacerbated by risks of climate change, over 50% of the city's urban area is now affected by regular floods (Duy et al., 2018). Vietnam's vulnerability to flooding is particularly acute due to the high population density and the concentration of economic assets in low-lying areas and river deltas. Consequently, the country has implemented various flood risk assessments that incorporate hazard, vulnerability and risk-based approaches (Nguyen et al., 2020). However, the effectiveness of flood adaptation strategies remains limited, primarily due to institutional challenges and difficulties in contextualizing flood risk management at the local level (Huynh and Stringer, 2018). This gap between assessment and implementation highlights the need for more integrated analysis to identify institutional factors and locally tailored flood resilience measures for long-term flood adaptation strategies.

For HCMC, scholars have primarily analyzed how climate change will affect the city. Exacerbated by risks of climate change, over 50% of the city's urban area is now affected by regular floods (Duy et al., 2018). Using the geographic information system (GIS), Duy et al. (2018) found that the lack of urban planning measures has increased flood vulnerability in newly emerging development districts within HCMC. The local government has continued to increase investments in further housing development despite the lack of adequate flood risk management. Advocating for resilient transport systems has, therefore, been recognized as a solution to mitigating flood vulnerability in HCMC (Duy et al., 2019). Since HCMC is heavily reliant on a "ground-level road network," prioritizing investments in resilient infrastructure will inevitably lead to developments that enhance accessibility, including housing and related systems such as sustainable drainage systems. Nonetheless, in addition to housing projects, the resilience of the transportation system in HCMC has also been overlooked, even though the increased frequency of flood incidents poses a higher risk to its stability (Duy et al., 2018, 2019).

Research on flood resilience in HCMC has also revealed complex dynamics between socioeconomic factors and adaptive capacities. Low-income households in marginalized districts of HCMC face heightened vulnerability to urban flooding due to lower livelihood security (Duy et al., 2018). However, these households have demonstrated adaptive behaviors over time, often implementing mitigation measures such as improving house floors, rather than relying solely on institutional support during flood events (Tu et al., 2024)

Despite these adaptive efforts, significant disparities in resilience persist, particularly along gender lines. Urban women in HCMC, especially those from disadvantaged groups, exhibit lower resilience due to unequal access to resources. This vulnerability is exacerbated by limited participation in decision-making and adaptation programs at the district level, largely due to the prevailing "top-down decision-making process" (Tran and Downes, 2023).

Recent research also highlights that resilience levels may vary within the private sector. Diez et al. (2024) found that small businesses, which comprise nearly 86% of all firms in HCMC, demonstrate a high willingness to participate in collective flood resilience efforts. While 70% expressed interest in joining flood awareness initiatives, 39% indicated openness to financial contributions if costs were shared among businesses and local authorities.

However, small businesses face considerable challenges compared to larger firms engaged in international value chains, particularly in finance and operations. This disparity is further emphasized by Le and Pham (2022), who observed that larger firms generally have easier access to environmental finance from Vietnam's

Environment Fund (EF) than their smaller counterparts. The information asymmetry between firms and the EF is a key barrier to assessing green finance. Many businesses, especially smaller ones, remain unaware of available financial support, even when initiating environmentally friendly projects. This information gap underscores the need for improved communication strategy to ensure that businesses can access the resources necessary for implementing flood adaptation measures regardless of size.

At the institutional level, Vachaud (2019) further highlights the existing challenges within HCMC in breaking down urban planning policies into "national, regional, and urban levels. Urban planning strategies in HCMC often focus on a single-sector or single-project approach, which fails to take into consideration the specific context of varying districts across the city. At the city level, Scheiber, David, et al. (2023) therefore emphasizes the need for incorporating flexible mitigation measures within low-elevation coastal zones of HCMC and advocates for a combination of large-scale flood protection infrastructure, e.g., ring dikes and smaller-scale decentralized rainwater detention systems. Their findings indicate that a lack of city-level assessment restricts the ability to implement more scalable, low-regret adaptation options that are resilient to urbanization and climate change trends.

3. Institutional Analysis and Development Framework

3.1. IAD Framework in the Context of Climate Resilience

Numerous analytical approaches have been used to evaluate climate risk and resilience, such as GIS-based flood modeling and creation of vulnerability indices. Although risk modeling provides projected estimates of flood exposure, less emphasis is placed on institutional or governance factors. For instance, while GIS-based hydrodynamic modeling can support urban flood mitigation efforts, it overlooks governance considerations (Hawchar et al., 2020). Vulnerability indices demonstrate whether there are socio-economic impacts but do not assess the effectiveness of corresponding policies (Tanir et al., 2024; Wehbe and Baroud, 2024).

The Institutional Analysis and Development framework (IAD) addresses these gaps by offering a structured, multi-level analysis of institutional coordination, stakeholder dynamics, and policy effectiveness, and thus, it is particularly valuable for assessing governance challenges in climate adaptation. IAD, developed by Polski and Ostrom (1999), provides a structured approach to analyzing complex institutional arrangements and their influence on policy outcomes. This structured approach enables integrating multiple participants, such as those directly invested in the policy outcomes. The IAD helps analysts and stakeholders to minimize potential oversight or simplifications that could produce policy failures (Polski and Ostrom, 1999) by dissecting complex social issues into manageable actions. Vitale and Meijerink (2023) applied the framework to examine urban flooding challenges in Italy, focusing on institutional and contextual factors that influence policy stability. Their study highlights how historical path dependence and centralization in flood risk policies can impede the transition to a holistic approach. The IAD is therefore useful to analyze the "ways institutions operate and change over time" (Roggero et al., 2018). The three components—exogenous variables, action arena, and outcomes—of the framework enables a comprehensive assessment of flood mitigation and adaptation strategies.

In the academic literature on climate adaptation, the IAD has been recognized by many scholars as a useful framework, as it not only provides a structured evaluation of how institutions influence climate adaptation processes but also reflects the collective choice arrangements and public actor adaptations (see review of papers by Roggero et al., 2018). In particular, Molenveld and Buuren (2019) analyze flood risk governance in the Netherlands using the IAD and demonstrate how governance structures have transitioned from rigid, prevention-based flood management to more adaptive resilience strategies. The

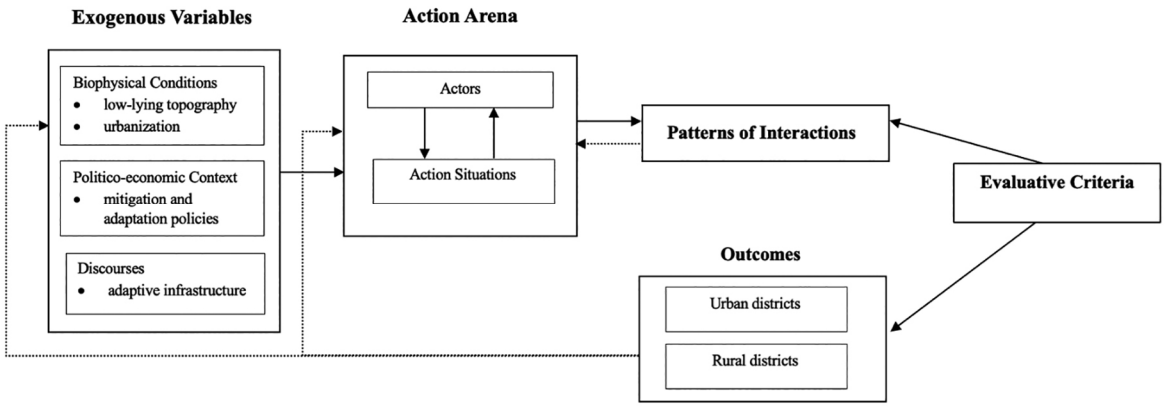
application of the IAD identified barriers to achieving adaptive governance, such as fragmented decision-making or institutional inertia. Findings also indicate that multi-stakeholder governance is needed to design more adaptive flood risk management strategies.

Moreover, the IAD has also been applied to explore financial sustainability amid climate change. For example, Mok (2023) applies the IAD to study how institutional arrangements impact financial sustainability. He emphasizes the significance of regulatory policies and talent management in enabling the financial market to incorporate sustainability. Additionally, Mok (2023) points out how climate change policies and market regulations affect institutional capacity, investment flows, and risk management strategies within financial markets through the IAD. Therefore, the IAD emphasizes the necessity of cultivating sustainable finance talent to achieve long-term financial stability in the face of climate-related challenges.

Similarly, Kiesling (2024) applies the IAD to explore financial sustainability within the electricity sector amid climate change. The study emphasizes that regulatory inflexibility and antiquated financial models hinder investments in low-carbon and decentralized energy technologies. Applying the IAD reveals a critical issue where financial mechanisms do not facilitate climate-oriented energy transitions. Consequently, Kiesling (2024) highlights the importance of aligning institutional policies with climate objectives and technological advancements to promote sustainable energy investments.

Against this backdrop, this study applies the IAD to analyze flood resilience strategies in HCMC, emphasizing the need for an adaptive flood resilience strategy that integrates institutional coordination, policy design, and local engagement into long-term urban flood governance (Fig. 1). The IAD for the study is grounded in its capacity to systematically evaluate governance structures, stakeholder interactions, and institutional constraints that shape urban flood resilience efforts in HCMC. Given the multifaceted nature of flood mitigation—encompassing governmental policies, community participation, and infrastructural development—, this framework offers an integrative perspective to evaluate the effectiveness of flood governance.

Regarding the IAD's relevance to urban flood resilience, this framework facilitates an in-depth exploration of how formal and informal institutions interact within the urban flood governance system (Polski and Ostrom, 1999). In the context of HCMC, flood mitigation is not solely dictated by top-down government directives but is also influenced by local district policies, international funding agencies, and community-based adaptation measures (Vitale and Meijerink, 2023). By applying the IAD, the study examines the coordination (or lack thereof) among these diverse actors and identifies



Source: Authors' own depiction adapted from Polski and Ostrom (1999), Vitale and Meijerink (2023).

Fig. 1. Institutional Analysis and Development (IAD) framework developed in the context of HCMC

institutional gaps that hinder effective policy implementation. While risk assessment primarily focuses on evaluating the "time- and location-specific" (Li et al., 2024) probability or potential impact of flooding events, resilience assessment examines the capacity of institutions, urban systems, and communities to adapt and recover from such climate-induced disruption (Marolla, 2024). Unlike risk assessments, which are often predictive, resilience assessment incorporates long-term adaptive strategies and governance effectiveness that influence the overall sustainability of flood mitigation efforts.

Thus, the study employs a qualitative analysis to analyze the effectiveness of HCMC's urban flood mitigation and adaptation policies in building climate resilience in a lower-middle-income country. National policies regarding urban flooding and climate change, literature reviews, governmental reports, and policy papers are examined to comprehensively assess the outcome of key national policies and programs. Quantitative measures, such as changes in the frequency or intensity of floods over time or advancements in drainage systems, will also be examined to analyze HCMC's adaptation efforts. Hence, this study aims to provide insight into the interaction between institutional, socioeconomic, and environmental factors in shaping urban flood resilience in the city.

Within the IAD, the selection of exogenous variables—biophysical characteristics, socioeconomic disparities, policy decisions, and interventions—was based on their direct influence on flood vulnerability and governance effectiveness in HCMC. The city's low-lying terrain and tropical climate exacerbate flood risks (Duy et al., 2018), while socioeconomic disparities influence adaptive capacity (Truong et al., 2022). Governance fragmentation further impacts policy implementation (Phi et al., 2015; Vitale and Meijerink, 2023). Using the IAD, the study further examines the institutional gaps, aligning with Roggero et al. (2018), who highlight the framework's role to analyze climate adaptation measures and resilience-building strategies.

The action arena focuses on the interactions among various stakeholders involved in the policymaking or implementation process. Key actors would include government officials, district-level authorities, or urban planners responsible for developing and implementing flood mitigation and adaptation policies, international organizations (IOs) that promote advocacy campaigns and community-based resilience programs. Vietnam's urban flood governance is mostly shaped by multi-level governance structures, where national policies, municipal authorities, and district-level initiatives interact (Phi et al., 2015). The IAD is useful for analyzing multi-tiered governance systems as it provides a structured methodology to assess how policy decisions at different levels align or conflict with each other (Vitale and Meijerink, 2023). Such application of IAD for flooding policies in Italy is relevant for HCMC, since the city also relies on national policies for flood management although there is variation across regions of both countries, i.e. exposure to oceans, rivers, and mountains. As a result, similar to Italian cities, urban flood resilience strategies in HCMC vary significantly across districts (rural versus urban), often leading to uneven policy outcomes (Duy et al., 2019).

The patterns of interactions in this study refer to coordination among key stakeholders, such as government agencies, municipal authorities, international organizations, and local communities, to implement flood mitigation and adaptation policies in HCMC. Vitale and Meijerink (2023) emphasize that fragmented governance can undermine resilience efforts, highlighting multi-level institutional coordination as a critical factor in policy effectiveness. Therefore, this study captures how institutional coordination and governance structures influence the implementation of flood resilience strategies in HCMC.

The evaluative criteria focus on institutional adaptability, policy effectiveness, and resilience outcomes. Institutional adaptability was assessed by how well governance structures integrate climate adaptation into urban planning. Policy effectiveness captures implementation success, stakeholder participation, and financial sustainability. The study assesses flood resilience

outcomes by comparing flood-affected urban and suburban areas in HCMC. This comparison is vital because urban flooding policies are implemented under different governance structures (Dieperink et al., 2018; Kinyanjui, 2024), infrastructure conditions, and rates of urbanization.

Although fully urbanized regions are often expected to be equipped with well-developed flood control infrastructure, this is not always the case. Francisco et al. (2023) point out that some densely urbanized cities still experience flooding due to outdated or insufficient drainage systems, rendering them susceptible to severe weather events. Similarly, Moon et al. (2024) argue that rapid urban growth can outpace infrastructure development, creating deficiencies in flood mitigation measures even in established cities.

Nevertheless, suburban areas usually possess less effective drainage systems than urban areas, which can be attributed to lower investment in infrastructure or decentralized floodwater management. By examining both types, this study offers a comprehensive evaluation of the effectiveness of these policies, highlighting weaknesses and differing impacts of flood resilience strategies across various urban environments. This approach ensures that policy recommendations address the needs of both highly urbanized and transitioning areas, improving overall flood management in HCMC.

Hence, as the IAD encompasses the political and economic context, the application of IAD enables an evaluation of how governance structures either facilitate or hinder the integration of climate resilience into HCMC's flood management strategies. By highlighting institutional constraints, the framework offers context-specific and adaptive strategies for policymakers to improve urban flood resilience (Polski and Ostrom, 1999).

3.2. Data Collection and Selection

This study examines climate resilience strategies in HCMC through qualitative assessment of national policy documents, evaluations of flood management, and climate adaptation frameworks sourced from both national and local levels. The criteria for selecting relevant information included the relevance to flood mitigation and adaptation policies from 2000 to 2023 and their applicability to HCMC's urban and rural districts. Other than national policy documents, reports from government agencies (e.g., HCMC People's Committee, MONRE), international organizations (UNDP, World Bank), and academic research were prioritized due to their credibility and relevance to climate resilience, in particular, flood mitigation and adaptation.

In addition, qualitative and quantitative data regarding socioeconomic vulnerability in flood-prone areas is analyzed to understand the socioeconomic dimensions of flood vulnerability and resilience. Quantitative data on rainfall intensity and frequency trends and urbanization and land use changes are also tracked to examine environmental conditions that contribute to urban flood resilience. The analysis was further guided by the IAD as proposed by Vitale and Meijerink (2023), which facilitated a comprehensive examination of the institutional arrangements and policy processes. The time frame for the analysis spans from 2000 to 2023 due to its significance in the context of HCMC's urban development and flood management initiatives.

Table 1 below represents the initiatives analyzed in this paper. In such a period, eight national efforts have been introduced to reduce urban flood risks relevant to the context of HCMC (Table 1). The First Master Plan (2001), supported by the Japan International Cooperation Agency (JICA), aimed to improve storm sewer systems and landfills. Although 40% of the flood control projects were completed after 15 years, significant improvements were observed, particularly in the city's central areas (Phi et al., 2015). In 2008, the National Target Program to Respond to Climate Change was introduced, emphasizing climate-adaptive urban planning, flood-resilient residential areas, and disaster prevention measures (MONRE, 2008). This was followed by the National Action Plan on Climate Change (NAPCC) (2012 ~ 2022), proposed by Prime Minister Nguyen Tan Dung. The NAPCC aimed to reduce greenhouse gas emissions, strengthen climate

Table 1. Vietnam's key measures for urban flood mitigation and adaptation with relevance to HCMC

Type	Name	Domestic Implementing Agency (ies)	International Cooperation Agency (ies)	Year	Reform
National Strategy	First Master Plan	People's Committee of Ho Chi Minh City (PCHCMC); Department of Natural Resources and Environment (DONRE); Department of Transportation and Public Works	Japan International Cooperation Agency (JICA); World Bank (WB); Asian Development Bank (ADB)	2001	Yes
National Program	National Target Program to Respond to Climate Change by the Ministry of Natural Resources and Environment	Ministry of Natural Resources and Environment (MONRE)	n/a	2008	No
National Policy	PM's decision on National Action Plan on Climate Change (2012 ~ 2020) of Vietnam	Ministry of Natural resources and Environment (MONRE)	n/a	2012	No
National Program	Mekong Urban Flood Resilience and Drainage Program	Ministry of Construction of Vietnam (MoC)	German Agency for International Cooperation (GIZ); Swiss State and Secretariat for Economic Affairs (SECO)	2013	No
National Project	HCMC Flood Risk Management Project	HCMC Steering Center of the Urban Flood Control Program (SCFC)	WB	2015	No
National Strategy	National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020 (NDPRM 2020)	Ministry of Agriculture and Rural Development (MARD)	United Nations Development Program (UNDP); WB; ADB	2017	Yes
National Law	Law on Natural Disaster Prevention and Control	The National Assembly	n/a	2019	No
National Strategy	National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2030, Vision to 2050 (NDPRM 2030)	Ministry of Agriculture and Rural Development (MARD)	UNDP; WB; ADB	2021	No

monitoring and early warning systems, and implement urban flood mitigation through flood control projects, infrastructure improvements, and technical guidance (Nguyen, 2012). HCMC was identified as a key area requiring these initiatives.

In 2023, the Mekong Urban Flood Resilience and Drainage Program was implemented as the second phase of Vietnam's Flood Proofing Program, focusing on strengthening urban flood resilience in the Mekong Delta, including HCMC. Funded by the Swiss State Secretariat for Economic Affairs (SECO) and executed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the program emphasized integrating flood risk analyzing, drainage planning, and disaster risk management to protect urban homes and livelihoods (GIZ, 2017). Around the same period, the HCMC Flood Risk Management Project was launched HCMC Steering Center of the Urban Flood Control Program (SCFC, 2015), following the 2014 Law of Environmental Protection. This project, aligned with World Bank regulations, sought to enhance drainage systems and flood resilience in critical urban areas, reinforcing Vietnam's broader environmental protection and poverty reduction objectives.

Recognizing the increasing flood risks, the Vietnamese government introduced the National Strategy for Natural Disaster Prevention, Response, and Mitigation in 2020 and 2017. This strategy prioritized urban flood management for sustainable socioeconomic development and national security, promoting forecasting improvements, relocation of at-risk populations, and green infrastructure integration, such as water retention systems and urban green spaces (Vietnam Government, 2021). In 2019, the Law on Natural Disaster Prevention and Control was passed, outlining disaster prevention responsibilities for government agencies, organizations, and individuals. The Law mandated the periodic adaptation of natural disaster prevention strategies every ten years and required local disaster response plans to incorporate climate change risk assessments (Climate Change Laws of the World, 2019).

The most recent development in urban flood mitigation is the National Strategy on Natural Disaster Prevention, Response, and Mitigation to 2030 (NDPRM 2030) introduced in 2021. This long-term strategy sets ambitious targets, including reducing flood-related casualties by 50% compared to the 2011-2020 period covered by NDPRM 2020, enhancing forecasting and early warning capabilities, and strengthening community-based disaster preparedness. Additionally, NDPRM 2030 aims to ensure that all government agencies receive comprehensive disaster prevention training and that national and regional disaster prevention databases are fully developed. Raising awareness of flood risks and implementing proactive measures to reduce flood damage are also emphasized in NDPRM 2030 (Vietnam Government, 2021). This sequence of policies and initiatives demonstrates Vietnam's evolving approach to urban flood resilience management in HCMC, integrating structural and non-structural measures, international cooperation, and long-term climate mitigation and adaptation strategies.

3.2.1. Institutional, Socioeconomic, and Environmental Dimensions of Climate Resilience in HCMC

Institutional capacity is a key determinant of climate resilience, but recent research indicates HCMC grapples with governance issues that impede effective measures. A study by Phuong et al. (2018) addressed this challenge through qualitative interviews with government officials across various levels. Their findings reveal "policy paralysis", whereby policy actors feel reluctant to actively take responsibility for coordinating climate adaptation action.

Socioeconomic vulnerability also interacts with institutional capacities to play crucial roles in shaping a city's overall resilience to urban flooding. In lower-middle-income countries with high population densities, such as Vietnam, the urban core areas are typically characterized by "low-rise housing structures" (Storch et al., 2013). This urban layout increases the risk of pollution and disease exposure during and after flood events, as floodwater can easily infiltrate homes, potentially leading to the spread of waterborne diseases (Givental, 2014). Such vulnerability has also been documented among a suburban district of HCMC that are highly exposed to climate change. Truong et al. (2022) analyze vulnerability across sixteen communes, the lowest administrative unit, and find that the most vulnerable town was the riverside communes located in low-lying terrain and close to rivers. The relatively poor households with low socioeconomic conditions tended to reside in these communes, and a key factor contributing to their heightened vulnerability was the low education levels among residents, which affect both formal and informal skill development. Such educational deficit restricts access to crucial knowledge and information, ultimately hindering households' adaptive capacity.

Despite these challenges, women in low-income urban households demonstrate marked resilience to flood risks. Even with limited resources and employment opportunities, they carry out multiple responsibilities, including household management, income generation, and flooding protection (Tran and Downes, 2023). Their proactive measures, such as constructing makeshift barriers and using sandbags, play a critical role in safeguarding homes from floods. Moreover, HCMC has abundant community-based organizations focusing on

climate resilience, such as the Women's Union, Youth Union, and Veteran Unions, 500 women-led climate-focused clubs. These organizations enhance access to flood-related information and foster community-driven resilience efforts. However, the long-term sustainability of these initiatives is threatened by insufficient institutional funding, highlighting that there exists institutional support gap.

On a related note, although socioeconomic factors contribute to vulnerability, recent studies suggest that institutional factors may play a more significant more role than socioeconomic conditions in determining flood resilience. A study by Tu et al. (2024) examined household-level vulnerability to flooding across four districts of HCMC, representing urban, peri-urban, and rural areas. Their findings revealed a weak correlation between household vulnerability and flood exposure, indicating that socioeconomic factors alone did not fully explain flood exposure. Yet, urban areas faced higher flood risks, compared to rural areas due to rapid urbanization. This urban-rural disparity in flood vulnerability underscores how fragmented climate adaptation efforts across governmental levels and limited private sector investment in climate adaptation have persisted (Phuong et al., 2018; Tu et al., 2024).

Alongside institutional and socioeconomic factors, environmental and biophysical characteristics also influence flood vulnerability in HCMC. The Center for Hydro-Meteorological Data of Vietnam has reported a substantial increase in the frequency of heavy rainfall events exceeding 100 mm over the past three decades, from five occurrences in 2009 to twenty by 2018 (Ho et al., 2014; Wu et al., 2021). A spatial analysis of urban flood vulnerability in HCMC reveals significant variations across the city; central and northeastern areas are particularly vulnerable, while the western area experiences comparatively lower vulnerability (Wu et al., 2021). Land subsidence is another environmental factor that exacerbates the vulnerability to urban flooding. Ho (2007) compare the average land subsidence rates in influencing flood mitigation or adaptation strategies across different cities in Southeast Asia, including HCMC, and find that subsidence rates above 2cm per year are considered severe and require urgent adaptation measures. The observed subsidence rates are 5cm to 27.6cm based on observed subsidence sites across the districts (6, Binh Tan, and 8) in HCMC. Such spatial distribution of flood vulnerability indicates that factors such as topography, draining infrastructure, and urban development patterns, will require targeted flood resilience strategies across the city.

4. Analysis Results

Ho Chi Minh City's approach to urban development and flood management has evolved significantly over the past two decades. The early 2000s marked the beginning of rapid urbanization and industrialization that initially prioritized real estate plans over long-term flood risk considerations. In 2001, HCMC introduced the First Master Plan for Flooding Prevention, developed with guidance from JICA, aimed at improving flood control and urban development management.

A key milestone also occurred in 2013 with the implementation of the Robust Decision Making (RDM) model, introduced by the World Bank and Global Green Growth Institute (GGGI), marking Vietnam's first use of advanced decision-support tools for flood management (Lempert et al., 2013). In 2016, Phase 1 of the Master Plan for Flooding Prevention and the Urban Flood Control Project were launched. This ambitious project was suspended between 2018 and 2020, due to lack of financial capital and accountability issues with the contractor. In the current decade, the central government issued a resolution in 2021 to resume this project, and HCMC has implemented projects through the Mekong Urban Flood Resilience and Draining Program (Lee et al., 2023).

4.1. Exogenous Variables

Flood risks in HCMC are shaped by a combination of biophysical, socioeconomic, and institutional factors that influence governance responses and mitigation and

adaptation measures. In terms of biophysical geography, HCMC's low-lying geography, exposure to sea-level rise, and rapid urban expansion contribute to high exposure to urban flooding. GIS-based flood hazard mapping and municipal hydrology reports indicate that Districts 7, Nha Be, and Can Gio are among the most flood-prone areas, where urbanization has affected natural drainage patterns, exacerbating inundation risks (Duy et al., 2018).

Seasonal monsoon flooding has also worsened due to the inadequacy of existing drainage networks to handle increasing surface runoff, particularly in rapidly developing districts (Ho, 2007; Ho et al., 2014). Similarly, Scheiber, David, et al. (2023) note that low-elevation coastal zones face increased vulnerability to flooding due to overlapping pressures from urbanization, climate change, as well as the poor quality of infrastructure. In these areas, not only do environmental factors increase urban flood vulnerability, but human-induced factors such as groundwater extraction or land subsidence also exacerbate the situation.

Socioeconomic disparities further contribute to uneven flood resilience across districts. Tu et al. (2024) also reveal that low-income residents in peri-urban districts, such as Binh Chanh and Nha Be, face significant challenges in accessing government-supported flood mitigation projects. While wealthier districts, including Districts 1 and 3, benefit from major investments in underground drainage systems and tidal embankments, lower-income communities rely on self-financed adaptation measures, e.g. constructing informal flood barriers or relocating to higher ground (Ho, 2007; Ho et al., 2014; Tu et al., 2024). Additionally, women-led households and marginalized groups have limited access to financial aid or adaptation support (Tran and Downes, 2023). These findings suggest that the effectiveness of flood mitigation and adaptation policies is shaped by economic inequalities and social vulnerabilities.

At the institutional level, Vietnam's flood risk management strategies have progressively evolved, integrating climate change considerations into national and local governance frameworks. The NDPRM 2020 initiated the enhancement of forecasting systems and upgrading flood control infrastructure, which includes the establishment of zoning maps or plans to assess flood risks (Vietnam Government, 2007). Moreover, national programs aimed to strengthen the capacity of flood forecast and warning in the Mekong River Delta, along with management of erosion-prone areas. The NDPRM 2020 also introduced a structural program to strengthen sea dike systems, aligning flood control efforts corresponding to the geographic and socioeconomic conditions of districts in HCMC. However, the strategy's implementation faced challenges due to inconsistencies in time-bound indicators, where some initiatives, such as sea dike improvements, had fixed timeframes (2007 ~ 2015). In contrast, broader flood management efforts lacked a clear deadline (Vietnam Government, 2007).

Building on these efforts, the NDPRM 2030 introduced a more comprehensive and adaptive framework for climate resilience. In contrast to the NDPRM 2020, the NDPRM 2030 prioritizes non-structural measures, e.g. the development of a database to improve government coordination across national, regional, and local scales. Moreover, the strategy sets quantifiable resilience targets, such as reducing fatalities from flash floods by 50% compared to 2011 ~ 2020 levels and ensuring that all government agencies, organizations, and households receive training in natural disaster prevention. Furthermore, the strategy highlights the need for a more transparent and consistent policy framework to enhance climate resilience against urban flood risks (Vietnam Government, 2021).

Despite these advances, governance fragmentation and financial constraints remain key barriers to effective policy implementation in HCMC. Phi et al. (2015), for instance, reveal a misalignment between national flood risk policies and their execution at the province and district levels. For instance, findings indicate that multiple agencies—including the Ministry of Natural Resources and Environment, the HCMC People's Committee, and district authorities—operate in silos, leading to coordination challenges and overlapping responsibilities.

Furthermore, budget constraints have also impeded large-scale flood resilience programs. The 2016 HCMC

Flood Control Master Plan, which proposed extensive infrastructure projects, was halted in 2018 due to funding shortages, demonstrating the financial sustainability challenges of such initiatives. While international donors such as the World Bank and JICA have provided funding and technical expertise, Lempert et al. (2013) indicate that many of these externally funded projects struggle with long-term integration into local governance structures. These institutional challenges highlight the need for improved multi-level governance coordination, financial sustainability mechanisms, and localized resilience strategies to support HCMC's climate resilience.

4.2. Action Arena

The governance of flood management in HCMC involves multiple actors, yet coordination gaps between national, province, and district authorities seem to remain a key barrier to effective flood resilience.

At the national level, the Ministry of Natural Resources and Environment (MONRE) and the Ministry of Agriculture and Rural Development (MARD) lead flood management policies. This is evident through national initiatives—the *National Strategy for Natural Disaster Prevention, Response, and Mitigation (2021)* and the *National Target Program to Respond to Climate Change (2008)*—that demonstrate Vietnam's commitment to climate mitigation and adaptation. These policy efforts aim to promote infrastructure improvements, early warning systems, and community engagement, yet the effectiveness varies across HCMC.

The key limitation is city-level data on implementation. For instance, while the *HCMC Steering Center of the Urban Flood Control Program* has initiated local projects to enhance drainage systems, reports indicate that only about 40% of its planned flood control projects were completed after 15 years of implementation due to funding and capacity constraints (Phi et al., 2015).

Furthermore, while HCMC's district-level authorities and urban planners were responsible for implementing national guidelines into effective local action, disparities across districts create uneven impacts. For example, the newly urbanized districts—Districts 2 and 7—have suffered from frequent flooding, exacerbated by a lack of cohesive flood prevention infrastructure. District authorities in vulnerable regions further struggle with limited resources and data to adapt national policies, which results in inconsistent mitigation measures.

In the context of international cooperation, various development actors have a marked presence in HCMC flood management. World Bank, JICA, UN-Habitat, and GGGI were prominent contributors to Vietnam's flood resilience efforts, primarily through financial support, advocacy, and capacity building. For instance, the *Green Growth City Development Strategy*, initiated by UN-Habitat and GGGI in 2012 and 2013, aims to incorporate green infrastructure and sustainable urban planning practices in flood-prone areas and provides valuable insights that could be applied to flood-prone areas in HCMC (GGGI and UN-Habitat, 2019).

Yet, the amount of involvement or effectiveness of such international cooperative agencies remains unclear due to limited available literature. Additionally, the *World Bank's RDM model*, introduced in HCMC in 2013, further represents a city-specific approach to managing climate-related disaster risks, aiming to support local authorities in making flexible decisions under climate uncertainties Lempert et al. (2013), Nonetheless, assessing the effectiveness of such efforts in HCMC revealed challenges due to the lack of city-specific and timely data collection. As highlighted Lempert et al. (2013), the data gap in "reliable [and] high-resolution data" continues to act as a barrier to providing more localized climate adaptation solutions for the city. Such gap often leads international organizations to rely on national-level data, which disables formulation of specialized approaches in HCMC's urban landscape.

Community-based adaptation efforts have contributed to HCMC's flood resilience strategies, but their integration into formal governance structures remains inconsistent. Recent studies indicate that informal adaptation measures, such as household floodproofing, are more prevalent in peri-urban and rural districts where government intervention is limited (Nguyen et al., 2020; Tu et al.,

2024). This trend is particularly evident in Districts 6 and Nha Be, areas with unequal access to government flood relief programs, resulting in the lack of long-term adaptation support (Pham, 2017; Truong et al., 2022).

Participatory planning initiatives have shown some success in urban districts but remain underdeveloped in peri-urban communities (Pham, 2017; Phi et al., 2015). Moreover, women-led social networks and local advocacy groups play a significant role in disaster response and risk communication for flooding. However, these efforts receive minimal institutional support for long-term resilience planning (Lempert et al., 2013; Tran and Downes, 2023). Hence, strengthening multi-stakeholder collaboration and formalizing community engagement in decision-making processes may also be necessary for improving flood resilience outcomes, similar to findings in Vitale and Meijerink (2023).

4.3. Outcomes

4.3.1. Outcomes in Urban Districts

New urban districts in HCMC—District 2, District 7, District 9, District 12, Binh Tan, and Thu Duc—have seen an overall improvement in urban development; such growth has resulted in both benefits and increased flood vulnerability. These areas experienced rapid urbanization since the early 2000s, converting wetlands into impervious areas, which increased overall surface runoff and worsened flooding especially when there is pluvial flooding (Ho, 2007; Ho et al., 2014).

Despite efforts to mitigate flood risks through initiatives such as the Urban Flood Control Program, rapid urbanization has outpaced infrastructure development, leaving many of these districts vulnerable. For instance, since the mid-1980s, HCMC has been experiencing an exponential increase in overall rainfall intensity, measured over 100 significant flooding sites. Following a 127 mm rainfall event on May 16, 2005, around 20 sites have been affected monthly by high tides even after the rainfall (Ho, 2007; Ho et al., 2014). GIS projections further revealed that new urban districts are significantly impacted by flooding, especially in Districts 2 and 7 (Tran, 2014). Compared to old urban districts that benefit from pre-existing flood control infrastructure, new urban areas often lack adequate protection when tide levels exceed 1.5 meters (Ho, 2007; Ho et al., 2014).

While HCMC's First Master Plan in 2001 aimed to improve city-level sewer systems and regional landfills, the growing urban heat island effect and rapid expansion of urban areas have counteracted such efforts (Ho et al., 2014). For instance, the key challenge across new urban districts on flood resilience is the mismatch between the pace of urbanization and the development of flood mitigation infrastructure. Uncontrolled sprawl has led to insufficient drainage systems (Scheiber, Jalloul, et al., 2023). The conversion of natural wetlands into urban areas has increased surface runoff, exacerbating flood risks from increased flooding. Moreover, future population growth projections indicate that unless mitigation measures are significantly improved, new urban districts will continue to face increasing flood risks in the coming decades (Lempert et al., 2013).

4.3.2. Outcomes in Suburban Districts

Similarly, the suburban districts of HCMC, including Binh Canh, Can Gio, Hoc Mon, Cu Chi, and Nha Be, are particularly vulnerable to flooding due to their low-lying topography and proximity to rivers. In particular, those alongside rivers are highly susceptible to flooding because these districts do not benefit from pre-existing flood control infrastructure, leaving them heavily exposed during flooding events. Suburban districts tend to be much more vulnerable, especially during periods of heavy flooding, because they lack sufficient drainage systems nor robust flood infrastructure compared to central and urban districts (Tran, 2014).

Another primary challenge in these districts is the lack of targeted infrastructure investment and comprehensive flood risk management. Current flood models are insufficient, making it difficult to predict and manage flood risks effectively (Amaral et al., 2023; Scheiber, Jalloul, et al., 2023). In response, national flood resilience policies—NDPRM 2020 and NDPRM 2030—have introduced new structural and non-structural measures to

enhance rural flood resilience (Vietnam Government, 2007, 2021). While the NDPRM 2020 focused on infrastructure-based measures, the NDPRM 2030 integrated more non-structural measures, e.g. the development of a unified disaster database and more transparent policy frameworks. Despite national-level initiatives aimed at enhancing flood resilience, rural and suburban districts of HCMC often face significant adaptation gaps. These disparities arise from a misalignment between national strategies and the localized implementation capacity of these areas.

At the community level, flood resilience awareness programs were implemented to increase knowledge and awareness among suburban residents. While suburban residents were educated on how to engage in proper waste disposal or cleaning programs for pre- and post-flood events (Anh, 2017; Anh and Ngoc, 2019), inconsistency in participation levels was observed.

5. Conclusion

The present study applied the Institutional Analysis and Development framework to assess the effectiveness of climate mitigation and adaptation measures for urban flood resilience in Ho Chi Minh City (HCMC). The study identified institutional, socioeconomic, and environmental challenges that shape HCMC's flood governance by examining the exogenous variables, the action arena, and policy outcomes. Findings reveal a significant urban-rural divide in flood resilience strategies, where urban districts have benefited from improved infrastructure, but rapid expansion and governance fragmentation hinder long-term sustainability. Conversely, rural districts remain highly vulnerable due to a lack of financial resources, weak institutional coordination, and a reliance on self-adopted resilience measures.

Initiatives such as the National Strategy for Natural Disaster Prevention, the National Target Program to Respond to Climate Change, the NDPRM 2020, and the NDPRM 2030 provide a comprehensive framework for enhancing mitigation and adaptation capacity. However, their implementation at the municipal level remains fragmented and financially constrained. The study, therefore, highlights policy gaps in financial sustainability, stakeholder coordination, and data accessibility that hinder HCMC's ability to develop long-term flood resilience strategies. Thus, the study's findings emphasize the need for an adaptive and sustainable flood resilience strategy incorporating institutional reforms, financial innovation, and more localized climate adaptation measures to tackle governance fragmentation and ensure long-term flood resilience in HCMC.

The study contributes to existing research on urban flood resilience by providing additional insights based on the application of the IAD. Such evaluation allows structured, multi-level analysis of governance challenges with current policies on flood resilience in HCMC. As a result, findings shed light on the importance of improving institutional coordination and ensuring financial sustainability in climate adaptation initiatives.

Moving forward, this study suggests three recommendations. First, strengthening multi-stakeholder governance and institutional coordination may be important to ensure better alignment between national, municipal, and district-level flood resilience measures. This includes establishing centralized flood resilience coordination efforts with government agencies, researchers, and local communities to streamline food response efforts.

Second, improving financial sustainability and investment mechanisms may be critical for supporting long-term flood resilience projects. One recommendation is to develop public-private partnerships or create a dedicated climate resilience fund, which may help secure sustained financial resources for both structural and non-structural measures and ensure non-commercial risks.

Third, the study suggests having more integrative data-driven planning and adaptive governance approaches to improve predictive flood risk modeling and real-time monitoring. Utilizing geospatial technologies and early warning systems may enhance HCMC's ability to respond proactively to climate-induced flood risks and ensure that resilience strategies remain adaptive to future climate uncertainties.

Although this study provides a comprehensive resilience assessment using the IAD, its limitations arise from reliance on policy reports and secondary data. While these sources are useful for institutional analysis, they may not fully capture the stakeholders' perspectives on the ground. The financial feasibility of proposed policy interventions also remains an area for further study, as evaluating the long-term scalability of resilience projects is crucial for effective implementation. Future research could address this by incorporating field-based case studies or interviews to provide contextual understanding. Additionally, although this study focuses on HCMC, future research might utilize the IAD in the context of other flood-prone cities in developing countries to shed light on whether there are similar challenges that require bilateral or multilateral cooperation.

Addressing these institutional, financial, and governance challenges is crucial in the context of HCMC to establish a more adaptive flood resilience strategy that supports national climate objectives while promoting sustainable flood mitigation and adaptation efforts in both urban and rural areas. Consequently, the study highlights the importance of adaptive flood resilience strategies and demonstrates how the IAD can help analyze institutional challenges related to climate adaptation across scales. The structured approach offers a solid framework for assessing policy effectiveness, serving as a useful tool for researchers and policymakers tackling urban flood risks in cities of the Global South.

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