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Proposed Model for Jakarta's Adaptation Strategy Towards a Global City from a Water Resilience Perspective

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Abstract

Purpose: This study proposes a theoretical model to analyse water resilience as part of Jakarta's adaptation strategy towards becoming a resilient and sustainable global city, focusing on three aspects: water governance vulnerability, city resilience status, and adaptation strategy as the main policy response.

Study Design/Methodology/Approach: This study uses a qualitative conceptual approach based on literature review and document analysis. The model was developed by integrating global city theory, social-ecological interaction theory, adaptation strategy, and national resilience. Relevant academic studies and policy documents on Jakarta's water governance, PAM Jaya, piped water service expansion, and urban resilience were reviewed to identify the main dimensions and indicators of the proposed model.

Findings: The proposed model connects three elements: water governance vulnerability as the independent variable, city resilience status as the mediator variable, and adaptation strategy as the dependent variable. The model suggests that higher water governance vulnerability may weaken city resilience, while stronger city resilience may support more effective adaptation strategies through infrastructure improvement, institutional strengthening, stakeholder collaboration, and community participation.

Originality/Value: This theoretical model represents both the concept of water security and global city theory, which is embedded in its strategic framework with the Asta Gatra idea. It is also conceptually and policy relevant for other large cities in developing countries facing similar challenges in water governance, urban resilience, and urbanisation pressure.

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INTRODUCTION

The complexity of development in large cities in the 21st century is influenced by the acceleration of digital transformation and the impact of climate change (Dixon & Eames, 2014). Consequently, all urban areas face increasing pressure on natural resources, infrastructure, and environmental capacity, as well as global challenges such as degradation, resource scarcity, and social inequality. As a result, urban areas are no longer merely centres of population and economic concentration but rather play a role as drivers of global development, which must be taken into account in the sustainability agenda (Oliveira, 2019). Therefore, as stated by Zeng et al., (2022), urban areas must transform to become sustainable and resilient, especially in responding to multidimensional risks such as water crises, population pressure, and climate disasters. This paradigm shift in thinking must be reflected in various global initiatives including the 100 Resilient Cities programme, which encourages the systemic development of cities' adaptive capacity to physical, social, and economic challenges (Kochskämper et al., 2025). Water resilience therefore deserves particular attention, as failures in water provision can quickly affect public health, infrastructure performance, environmental quality, and the continuity of urban economic activity.

Urban resilience stems from the concept of the global city, which essentially declares an urban area as a strategic region. This strategic region can be seen systemically, with indicators assessed through economic, social, political, and institutional strengths (Sassen, 2001). The global city concept emphasises that a city's capacity to manage risks, maintain resource sustainability, and ensure the stability of basic services is a key requirement for maintaining its position within a dynamic global network (Batty, 2016). Therefore, the attributes of a global city are determined not only by infrastructure and connectivity but also by its resilience capacity to respond to uncertainty and multidimensional crises (Zebrowski, 2020). For Jakarta, this means that the ambition to become a global city must be supported by reliable basic services, particularly clean water, sanitation, and environmental protection.

Urban resilience in Indonesia, especially Jakarta, is part of national resilience. The *Asta Gatra* concept identifies geography, natural resources, and population as strategic strength areas, placing Jakarta at the forefront of government and economy. This position, in turn, makes even the smallest interruption of basic services including clean water and sanitation potentially able to create systemic impact toward social stability, economy and national security (Fuady et al., 2025; Sofiyah & Suryawan, 2025; Tarigan & Mahera, 2020). This degree of vulnerability is demonstrated by Jakarta's performance in the 2024/2025 Global Cities Index, whereby it was ranked 71st out of 156 global cities and performed relatively poorly with respect to environmental aspects, infrastructure resilience and governance (Lohmeyer & Buckstaff, 2025). Seen from the *Asta Gatra* perspective, water governance is not limited to environmental management. It is also linked to geography, natural resources, demography, economic stability, socio-cultural order, and defence and security.

One of the central issues on the resilience agenda in Jakarta lies in the urban water sector. The lack of safe water, encompassing aspects of quantity, quality, continuity, and

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accessibility, poses a serious threat to the region's sustainability (Taftazani et al., 2022). Unequal distribution of clean water services, dependence on contaminated groundwater, land subsidence, water body pollution, and limited infrastructure indicate significant levels of vulnerability (Taftazani et al., 2022). Consequently, Jakarta ranks 71st out of 156 global cities in the 2024/2025 Global Cities Index, with key weaknesses in environmental aspects, infrastructure resilience, and governance (Lohmeyer & Buckstaff, 2025). Despite the implementation of several policies, including the provision of SPAM (water supply systems), an increase in treatment capacity, the reduction of non-revenue water losses (NRW), and institutional reform following Jakarta Drinking Water Services (PAM Jaya) municipalisation, challenges related to regulation, inter-institutional coordination, and equitable distribution continue to pose significant hurdles in urban areas (Evaristo et al., 2023; Dany; et al., 2025).

These conditions show that Jakarta's water problem is not only a matter of infrastructure provision, but also a governance issue that affects the city's wider resilience and its readiness to compete as a global city.

Although previous studies have examined Jakarta's water security, urban resilience, global city transformation, and national resilience, these themes are often discussed separately. There remains a need for a model that brings together water governance vulnerability, city resilience status, and adaptation strategy within the Asta Gatra framework. This gap is important because Jakarta's global city agenda depends not only on economic competitiveness and infrastructure modernisation, but also on the capacity to secure resilient, equitable, and sustainable water governance. The main contribution of this study is therefore the formulation of a theoretical model that links global city theory, socio-ecological interaction theory, adaptation strategy, and national resilience in explaining Jakarta's water resilience.

Therefore, this study aims to formulate a proposed theoretical model on analysing water security as an integral part of Jakarta's adaptation strategy to become a resilient, sustainable, and competitive global city. Given the complexity of the challenges faced, the theoretical model must examine Jakarta's water security in depth, focusing on three research questions or objectives. The first objective is to analyse the vulnerability of Jakarta's water governance in promoting city resilience towards achieving global city status. Second, to assess the implementation status of the urban resilience concept, particularly in the water governance sector, in Jakarta. Thirdly, to formulate we will formulate adaptation strategies aimed at enhancing Jakarta's water resilience. The theoretical model will be developed from four theories and concepts: global city theory, socio-ecological interaction theory, the adaptation strategy concept, and the national resilience concept. This study offers a conceptual basis for understanding water resilience as a strategic component of Jakarta's urban transformation, while also providing a policy-oriented perspective for strengthening water governance within the broader agenda of national resilience.

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LITERARURE REVIEW

Jakarta in National Resilience and Global City Index

Jakarta's agenda toward a global city is gaining momentum (Nuaba, 2025). Jakarta possesses required demographic and economic capital. Jakarta have population of 10.75 million in 2023, which approximately 71.36% are in productive age (Badan Pusat Statistik Provinsi DKI Jakarta, 2022). Jakarta also contributes to 16.1% of the national GDP by trading, manufacturing, financial services, construction, and information and communication sectors (Hudalah et al., 2013; Nur & Rakhman, 2019). Jakarta's development pattern is multi-functional that can push agglomeration and economic activity. The development of Jakarta can be watch from the increase of brightness in Night-Time Light (NTL) satellite image (Putri et al., 2020).

Jakarta is attractive to foreign direct investment and is listed in various global city indexes, for example the Global Power City Index, the Cities in Motion Index, the EIU Liveability Index, and the Global City Index (IESE Business School of Navarra, 2025; Institute for Urban Strategies The Mori Memorial Foundation, 2024; Nuaba, 2025; The Economist Intelligence Limited, 2025). Beside indexes from external institutions, the Jakarta Provincial Government has also formulated global city performance indicators covering aspect of economy, research and innovation, liability, culture, environmental sustainability, and connectivity (Nuaba, 2025; Syalianda & Kusumastuti, 2021). To achieve the index, digitalization, human resource development, integrated public services, environmental information systems, and public transportation have been implemented (Herdiana, 2024; Pakpahan, 2024). Empirical studies also confirm that the success of the global city still depends on the strength of basic services like clean water and sanitation management (Batty, 2016).

Vulnerabilities in Water Governance in DKI Jakarta

Jakarta’s water governance has vulnerabilities that constrains the city’s aspiration towards global city. Beside limitation of water availability, the vulnerabilities are rooted in ecological, institutional, and cross-regional governance challenges. Environmentally, the quality of Jakarta’s water resources face pollution in rivers and reservoirs, alongside groundwater degradation in several areas (Luo et al., 2019). Moreover, the city also has low water self-sufficiency with dependence on external water sources like Jatiluhur, Karian, and Juanda. This dependency expose Jakarta to risks like disruptions in upstream regions or transmission networks that are not serviced continually (Yanidar et al., 2018).

This dependency also shows a misalignment between ecological carrying capacity and urban demand. Rapid population growth and intensifying climate impacts amplify this imbalance. Morever, these pressure to ecological carrying capacity also met with governance constraints like high non-revenue water, funding limitations, uneven service coverage, and socioeconomic disparities among users (Ardhianie et al., 2022; Febriawati et al., 2021; Oktaviani et al., 2020). Although the municipalisation of water services through the full takeover by PAM Jaya have been done, fragmented governments coordination hinder the watershed-based management (Evaristo et al., 2023; Fransiskus Wisnu Wardhana Dany; et al., 2025).

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When assessed through the Urban Resilience Framework, the Jakarta's water governance is still in transitional phase. Policy interventions have only prioritised infrastructure expansion and technical solutions, without leadership integration, adaptive planning, and institutional learning. Consequently, water resilience is still treated as only sectoral concern, which oppositely should be a systemic process in urban development. Spatial and social inequalities in access to clean also appear as communities often only can rely on informal practices like excessive groundwater extraction that exacerbates environmental degradation.

Global City Theory

Global city theory explains that a city becomes important in the global system not because of size or population, but because of its ability to connect flows of capital, information, services, and power to the global economy (Ancien, 2011). Sassen, 2001 stated that this ability is commonly achieved by becoming an advanced producer of services like finance, legal, consulting, technology, and information services. Friedman (2002) described global cities as control centres of the world economy where headquarters of transnational corporations and global institutions are located. The Globalisation and World Cities (GaWC) classifies Jakarta as an Alpha city (GaWC, 2024). The Sustainable Development Goals (SDGs), especially Goal 11, emphasise that competitive cities must ensure the sustainable fulfilment of basic needs, covering access to clean water and sanitation (United Nations, 2015). Global cities do not only focus on economic growth and physical infrastructure but also on adaptivity towards global challenges like water scarcity, energy issues, and environmental crises (Ni'mah et al., 2021; Scott et al., 2020; Yasmin et al., 2022).

The transformation into a global city must be supported by the development of international airports, telecommunications networks, and modern central business districts and strengthened through the expansion of political and cultural diplomacy and active participation in global networks (Acuto & Leffel, 2020; Apostolopoulou, 2021). This expansion must be accompanied by an integrated approach to global economic impact and investment in high-tech manufacturing and service industries (Noyelle, 1983). After that, the city can reinforce the global economic command centre's role through the concentration of strategic institutions and international corporations' headquarters (Molotch & Logan, 1985). The transformation to a global city must be supported by the development of international airports, telecommunications networks, and modern central business districts and strengthened through the expansion of political and cultural diplomacy and active participation in global networks (Acuto & Leffel, 2020).

Decision-makers in urban areas should pay attention to innovative environments and welcome international talent through the promotion of research centres, universities, technology centres, and corporate ecosystems (Condom-Vilà, 2020). This process peaks when cities are formalised in global indexes including GaWC (GaWC, 2024; Kraus et al., 2021). However, failure to implement urban transformations in a gradual, orderly, or predictable manner has exacerbated socio-spatial inequalities and intensified pressures on urban sustainability. The development agenda is increasingly characterised by resilience and sustainability as the concept of a 'global city' evolves (Acuto & Leffel, 2020;

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Kochskämper et al., 2025; Krueger et al., 2022; Sassen, 2001). As shown in some studies, water governance is a key to improving quality of life and enhancing resilience as well as establishing sustainable cities.

Social-Ecological Interaction Theory

Social-ecological interaction theory stated that humans, institutions, and the environment are an integrated and interdependent social-ecological system (SES) (Partelow, 2018). The SES framework explains that the governance of common pool resources is determined by the interaction between actors, institutions, rules, and ecological conditions (McGinnis & Ostrom, 2014). Water crises are also influenced by user behaviour, institutional quality, regulatory compliance, and coordination among actors (Gittins et al., 2021). Krueger et al. (2025) showed that resilient social-ecological systems are characterised by adaptive feedback loops, where increased awareness and conservation practices reduce pressure on water resources. Oppositely, governance failures and low awareness will accelerate ecosystem degradation. In short, a community's vulnerability to environmental change is strongly influenced by adaptive capacity, which is built on education, public willingness to participate, and effective governance (Choden et al., 2020; Green et al., 2021).

Strategic Adaptation Concept

The adaptation strategies concept should be used in responding to environmental change and climate risk (Uddin et al., 2014). Adaptation refers to the preparation of social, economic, and environmental systems for the effects of climate change (Glover & Granberg, 2020). Smit & Wandel (2006) differentiate between two types of adaptation: autonomous adaptation, which takes place naturally from individuals or communities with water-saving measures, shifts in consumption patterns and the use of substitute sources. The second is deliberate adaptation, which involves an intentional orchestrated response by institutions through policies and intervention such as construction of water supply systems (SPAM), regulation of groundwater extraction, and reduction in pollution (Agarwal et al., 2012; Ploeg, 2011). The ability of adaptation measures to be implemented is characterised by the incorporation of societal responses (Nakicenovic & Swart, 2000) and institutional capacity to address environmental risk management issues.

National Resilience Concept

The concept of national resilience provides a framework for understanding a nation's survivability, stability, and sovereignty amidst threats and changes originating from internal and external factors (Hanita, 2020). Indonesia's national resilience is based on *Pancasila*, *Undang-Undang Dasar 1945* (the 1945 Constitution), and *Wawasan Nusantara* (Archipelago Insight). National resilience is classified into *Asta Gatra* (eight interrelated dimensions), i.e., geography, demography, natural resources, ideology, politics, economy, socio-culture, and defence and security (Daihani, 2024; Direktorat Pengkajian Bidang Sosial dan Budaya, 2013; Putranto et al., 2017; Shukor et al., 2025; Suryohadiprojo, 1997). This This framework is used to map threats, challenges, obstacles,

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and disturbances (ATHG) as a basis for strengthening stability and sustainable development. In an increasingly urbanised country, national resilience cannot be separated from that of urban areas, as metropolitan cities like Jakarta serve as centres for government, economy, demography, and infrastructure. Therefore, Jakarta's vulnerability will impact national stability. Therefore, urban resilience, especially in a capital city, can be understood as an operational derivative of national resilience (ARUP, 2025).

Water resilience is an important tool in connecting national resilience and urban resilience (Batty, 2016; Sofiyah & Suryawan, 2025). The water sector is closely linked with asta gatra in terms of natural, economic, and social aspects. The urban water resilience approach (UWRA) states that water resilience is based on governance, infrastructure, resources, community engagement, and adaptive risk management, as outlined by Malang City, which follows the collaborative principle of the penta helix. Based on this literature, Table 1 is presented.

Table 1. Four Pillars of City Water Resilience

CWRF Pillars	Focus	Performance Dimension	Implications for a Megapolitan City
1. Leadership & Strategy	Leadership, long-term vision, cross-agency coordination	Political leadership; decision-making capacity, adaptive regulation	Ensuring consistency of water policy despite changes in government or political pressure
2. Planning & Finance	Integrated planning, sustainable funding, risk management	Coordination of spatial planning–water; long-term financing; risk analysis	Ensuring the sustainability of water infrastructure investments like pipes, reservoirs and treatment plants
3. Infrastructure & Ecosystems	Physical infrastructure and ecosystem services	Reliability of pipeline networks; quality of water sources; watershed conservation	Strengthening grey–green infrastructure integration to mitigate floods, droughts, intrusion, and ecological degradation.
4. Health & Wellbeing	Public health, equitable access, quality of service	Water quality; universal access; community resilience	Reducing spatial disparities in water services and their impact on public health

Source: Adapted from the City Water Resilience Framework.

METHODS

This study uses a qualitative conceptual approach to develop a proposed theoretical model of Jakarta's adaptation strategy towards a global city from the perspective of water resilience. This approach is suitable because the study does not aim to test statistical relationships, but to build an analytical model based on theory, previous studies, and relevant policy documents (Creswell & Creswell, 2018; Jaakkola, E, 2020).

The analysis was carried out through a review of academic literature and documents related to Jakarta's water governance. The literature review focused on four main concepts: global city theory, social-ecological interaction theory, adaptation strategy, and national resilience. Global city theory was used to explain Jakarta's position in the global urban system and the importance of basic service resilience for city competitiveness (Sassen, 2001; Batty, 2016; Zebrowski, 2020). Social-ecological interaction theory was used to understand water governance as a relationship between natural resources,

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institutions, actors, rules, and society (McGinnis & Ostrom, 2014; Partelow, 2018). The concept of adaptation strategy was used to explain how institutions and communities respond to environmental risks and water-related challenges (Smit & Wandel, 2006; Uddin et al., 2014; Glover & Granberg, 2020). Meanwhile, the concept of national resilience was used to place Jakarta's water governance within the Asta Gatra framework (Hanita, 2020; Daihani, 2024).

The documents reviewed in this study include references related to Jakarta's water supply policy, PAM Jaya's role in piped water service expansion, water governance after municipalisation, and the City Water Resilience Framework. These documents were used to identify important issues in Jakarta's water sector, including service coverage, raw water dependency, infrastructure capacity, institutional coordination, environmental pressure, and community participation (ARUP, 2025; Evaristo et al., 2023; Fransiskus Wisnu Wardhana Dany; et al., 2025).

The analysis was conducted in three stages. First, the study identified the main vulnerabilities in Jakarta's water governance, including dependence on external raw water sources, groundwater and river pollution, uneven piped water service coverage, land subsidence, and weak inter-institutional coordination. These issues have been discussed in previous studies on Jakarta's water security and urban water management (Yanidar et al., 2018; Luo et al., 2019; Febriawati et al., 2021; Ardhianie et al., 2022; Taftazani et al., 2022). Second, these problems were linked to the concept of city resilience, particularly in relation to clean water accessibility, water source availability, institutional effectiveness, and infrastructure reliability. Third, the study formulated adaptation strategy dimensions related to infrastructure and technology, institutions, collaboration, and community participation.

Through these stages, this study produced three main analytical outputs: a conceptual framework, a proposed theoretical model, and a set of dimensions and indicators for each variable. The proposed model places water governance vulnerability as the independent variable, city resilience status as the mediating variable, and adaptation strategy as the dependent variable. This model provides a conceptual basis for understanding how Jakarta's water governance problems may affect city resilience and how adaptation strategies can support Jakarta's transformation towards a global city.

RESULTS AND DISCUSSION

Conceptual Framework

The conceptual framework explains the position of water resilience in Jakarta's urban development and national resilience agenda. It links water governance, government authority, public participation, policy implementation, and strategic environmental pressures.

Figure 1 shows the conceptual framework of this study. Water resilience is the main foundation for Jakarta's sustainability as a capital city and centre of national development. The government has authority in water governance. People and society are both the subjects and active participants in the implementation of policies and programmes. Water

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resilience is influenced by strategic environmental development, which consists of supporting and resisting factors such as climate change, land subsidence, flooding, seawater intrusion, urbanisation, and policy dynamics (Tarigan & Mahera, 2020; Taftazani et al., 2022). Therefore, the water crisis in Jakarta necessitates the development of an adaptation strategy to enhance national resilience. The adaptation strategy must combine infrastructure development, community capacity, and policy reform for clean water service improvement through a piped water system managed by PAM JAYA based on DKI Jakarta Governor Regulation Number 7 of 2022, to reduce groundwater use and environmental damage. Overall, water resilience is a requirement for Jakarta to move towards being a global city. Without a stable and sustainable water system, Jakarta will not be able to support long-term development and international competitiveness (Sassen, 2001; Batty, 2016; Zebrowski, 2020).

In this framework, water resilience is understood not only as an infrastructure issue, but also as a matter of governance capacity, social participation, and national resilience. From the Asta Gatra perspective, water governance is related to geography, natural resources, demography, economy, socio-cultural stability, and defence and security (Hanita, 2020; Daihani, 2024). Disruption in clean water services may therefore affect household welfare, urban stability, public trust, and national resilience.

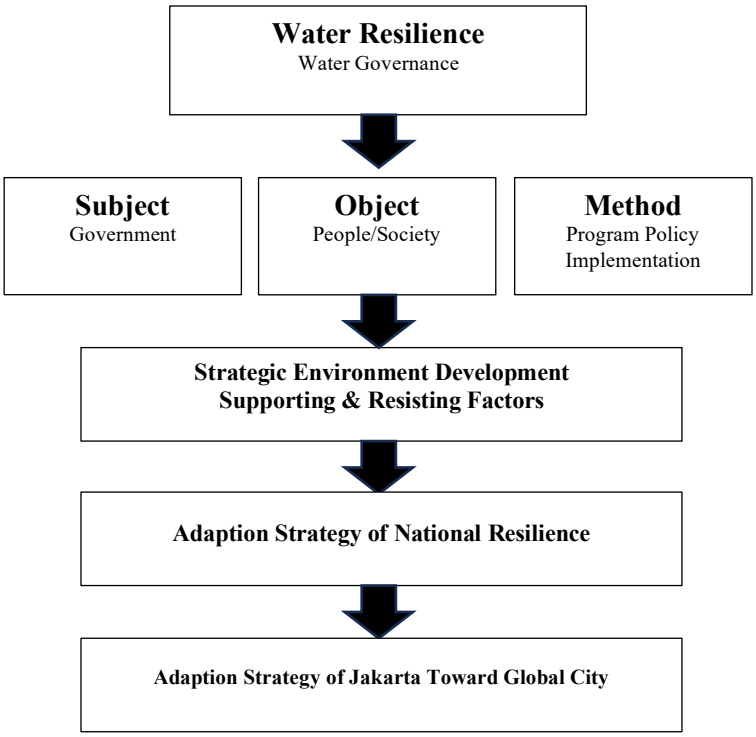

Figure 1. Conceptual Framework

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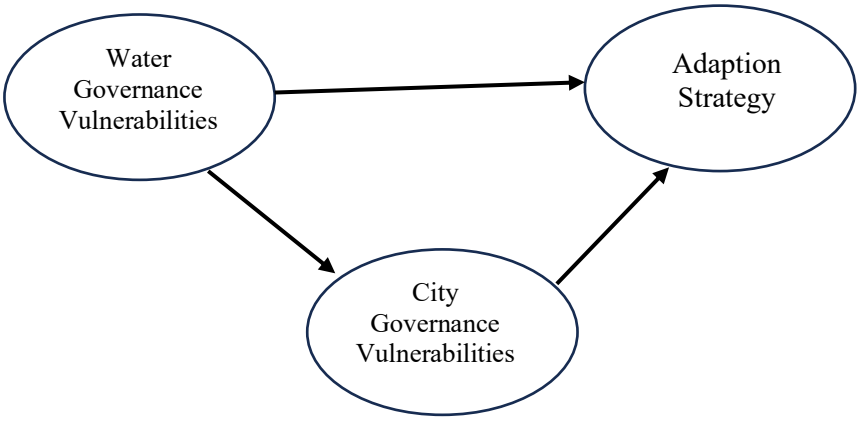

Figure 2. Proposed Theoretical Model

Figure 1 provides the general structure of the study. It places water resilience as the foundation, water governance as the organising mechanism, government and society as the main actors, and strategic environmental development as the external context. This framework is then specified in the proposed theoretical model shown in Figure 2.

Proposed theoretical Model

The proposed theoretical model was developed to clarify the relationship between water governance vulnerability, city resilience status, and adaptation strategy. It translates the broader conceptual framework into variables that can be examined in future empirical research.

This theoretical model explains the relationship between water governance vulnerability, city resilience status, and adaptation strategy to support Jakarta's transformation into a resilient global city. These three variables were developed through an integration of global city theory, social-ecological interaction theory, adaptation strategy, and national resilience. Within this framework, water governance vulnerability is defined as an independent variable reflecting the structural and functional conditions of the clean water system, such as dependence on external supplies, the quality of local resources, the coverage of piped water services, and environmental impacts such as land subsidence (Yanidar et al., 2018; Luo et al., 2019; Ardhianie et al., 2022; Taftazani et al., 2022). High levels of vulnerability reflect the potential for serious disruptions to the sustainability of Jakarta's water supply, ultimately affecting the city's capacity to maintain the resilience of basic services.

City resilience status is positioned as an intervening variable between vulnerability and adaptation strategy. Resilience is assessed by four main indicators: availability of clean water services, reliability of raw water supply, effective policy interaction and infrastructure resilience under environmental stresses. Adaptation strategy, as a dependent variable, represents the responses initiated by the Jakarta Provincial Government, PAM JAYA, and other related institutions through infrastructure development, institutional strengthening, stakeholder collaboration, and community participation. Therefore, enhanced water governance resilience should boost effective, relevant and sustainable adaptation strategies. The model applied in this study posits that

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WGV is negatively associated with urban resilience, and UR is positively related to AS. In addition, vulnerability is also an indirect factor affecting adaptation measures through the mediating effect of urban resilience.

The model indicates that weak water governance may reduce city resilience, while stronger city resilience may support better adaptation strategies. City resilience therefore explains how water governance problems shape adaptation responses in Jakarta's water sector.

The relationship among the variables is expressed in three propositions:

P1: Water governance vulnerability negatively affects city resilience status.

P2: City resilience status positively affects adaptation strategy.

P3: City resilience status mediates the relationship between water governance vulnerability and adaptation strategy.

The dimension and indicators for the variables used in the proposed theoretical model are described in table 2.

Table 2. Dimension and Indicator for the Variables

Variabel	Sub Variabel / Dimension	Indicator
Water Governance Vulnerability	Dependence on Raw Water Supply	Proportion of water supply from outside the region
	Local Water Source Quality	Level of groundwater/river pollution
	Piped Water Service Coverage	Percentage of households served by piped water
	Land Subsidence	The rate of land subsidence per year
City Resilience Status	Clean Water Accessibility	Percentage of households with access to clean water
	Availability of Water Source	Water supply to demand ratio
	Water Governance Institutions	Institutional effectiveness score for water governance
	Clean Water Infrastructure	Availability of water infrastructure network
Adaptation Strategy	Infrastructure Technology Strategy	Clean water infrastructure development plan or program
	Institutional Strategy	Institutional water governance policies & programs
	Collaboration Strategy	Level of stakeholder involvement in water policy making
	Community Participation	Level of community participation in water management programs

Table 2 presents the operational dimensions of the proposed model. Water governance vulnerability refers to the main pressures in Jakarta's water system. City resilience status refers to the city's capacity to maintain reliable water services. Adaptation strategy refers to the policy and institutional responses needed to strengthen water resilience. These indicators may be refined and tested in future empirical studies.

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The discussion shows that Jakarta's adaptation strategy towards a global city needs to begin with the identification of water governance vulnerability, followed by the strengthening of city resilience and the formulation of adaptation strategies based on infrastructure, institutions, collaboration, and public participation. This structure is consistent with the purpose of the study and with the qualitative conceptual method used in the research

CONCLUSION

This study proposes a theoretical model of water security as part of Jakarta's adaptation strategy towards a resilient and sustainable global city. The model places water governance vulnerability as the independent variable, city resilience status as the mediating variable, and adaptation strategy as the dependent variable. Through this model, water security is understood not only as an infrastructure issue, but also as a governance, social, environmental, and national resilience issue.

The study shows that Jakarta's water governance vulnerability is related to dependence on external raw water sources, the quality of local water resources, limited piped water service coverage, land subsidence, and institutional coordination challenges. These vulnerabilities may affect the city's capacity to maintain reliable basic services and strengthen its position as a global city. Therefore, improving city resilience becomes an important step in formulating adaptation strategies for Jakarta's water sector.

The adaptation strategy proposed in this study includes four main directions: infrastructure and technology improvement, institutional strengthening, stakeholder collaboration, and community participation. These directions are important to support clean water service improvement, reduce groundwater dependence, and strengthen Jakarta's resilience in facing climate change, urbanisation, and environmental pressure.

From an academic perspective, this theoretical model offers a conceptual basis for future empirical research and can be tested in several other large cities, especially in developing countries facing similar challenges in water resource governance and urbanisation pressures. From a policy perspective, the model can support the formulation of more integrated water governance policies by linking vulnerability, resilience, and adaptation strategy. Thus, the main objective of this research is to provide conceptual and practical contributions to strengthening water security, sustainable development, and city competitiveness at the national and global levels.

This study is limited to the development of a conceptual model. Further research is needed to test the proposed model using empirical data, either through quantitative analysis, qualitative institutional study, spatial analysis, or mixed methods research.

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