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Article

Collaborative governance flood disaster mitigation in Indonesia

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Abstract: The problem of flooding in the capital is still classified as a classic problem, but this problem still continues to emerge and becomes a trending problem during the rainy season in urban weather. This research aims to analyze the effectiveness of governance collaboration in overcoming the Jakarta flood problem. This research uses qualitative analysis and a content analysis approach. This research found that flood management using a collaborative governance approach was running optimally, the involvement of the private sector and the community was a good and rare synergy. support from international funding sources is used with effective management with the aim of using the budget on target. In the end, this research concludes that collaborative governance in Jakarta flood management is carried out optimally but requires sustainable collaborative efforts. This research has limitations in reaching the involvement of personal actors as a source of supporting information in disaster mitigation studies. Further research requires a more comprehensive discussion by reviewing the involvement of important actors in flood disaster mitigation.

Keywords: collaborative governance; flood disaster mitigation; Jakarta; community-based organizations; nature-based solutions; international collaboration

1. Introduction

The impact of flood disasters in urban areas concerns the public and policymakers because it results in fatalities and more significant economic losses (Qi et al., 2024). The increasingly rapid urbanization accompanied by climate change will have the potential to increase the potential for flooding (O'Donnell and Thorne, 2020; Qi et al., 2022; Tan and Schultz, 2021). In future projections for 2050, the urban population is estimated to reach 60%, potentially causing flood vulnerability (Mu et al., 2020). With the acceleration of urbanization, the risk of urban flooding increases, such as in developing countries where the rapid urbanization process is taking place. The severity of urban flooding is predicted to continue to increase in the future (Mcgrane, 2015; Macdonald et al., 2022; Sadler et al., 2018).

Jakarta, the capital city of Indonesia, has long been prone to flooding due to its geographical location and rapid urban development. Jakarta's geographical position in a low-lying coastal area makes it particularly susceptible to flooding from the sea and heavy rainfall. Seasonal monsoons exacerbate this problem, leading to frequent and severe floods (Firman et al., 2011). Situated in a lowland area and traversed by 13 rivers, including the significant Ciliwung River, Jakarta's flood susceptibility has been exacerbated by inadequate drainage infrastructure and environmental degradation. The city's drainage systems and flood control infrastructure have not kept pace with the rapid urban growth. Poorly maintained and inadequate drainage systems often fail to handle heavy rainfall, leading to severe urban flooding (Fitria et al., 2022).

Historically, severe flood events have plagued the city, with notable incidents in 2002, 2007, 2013, and 2014 (Caljouw et al., 2009; Goenawan et al., 2015; Liu et al., 2015; Texier, 2008). The 2007 floods were particularly devastating, inundating about 70% of the city, causing at least 57 deaths, and resulting in economic losses estimated at USD 1 billion (Cobián Álvarez and Resosudarmo, 2019). More recently, floods that occurred in early 2020 and 2021 showed how vulnerable the city of Jakarta is, with heavy rainfall flooding the drainage network and causing widespread disruption and displacement of resident (Putra et al., 2021).

Several factors contribute to Jakarta's flooding issues. Extreme rainfall events, characterized by high intensity and short duration, have become more frequent due to climate change (Setiawan and Ma'mun, 2021). Urban expansion and deforestation in upstream areas have reduced the land's natural absorption capacity, increasing surface runoff and flood risks (Khan and Ayub, 2021). Additionally, extensive groundwater extraction has led to significant land subsidence, further exacerbating flooding. Excessive groundwater pumping has caused large subsidence of the land surface, making these cities more vulnerable to flooding, especially during the rainy season (Kagabu et al., 2013). Approximately 35% of Jakarta's residents rely on groundwater, accelerating subsidence and reducing the city's water storage capacity (Wihanesta et al., 2021). The city's drainage and flood control infrastructure have struggled to keep pace with rapid urban growth, frequently failing during extreme weather events. The frequency and intensity of extreme weather events are rising due to climate change, further stressing inadequate urban drainage systems (Arnell and Gosling, 2016). In response to these persistent flooding problems, various policies and management plans have been implemented. The Water Resource Management Act 2004 No. 7 (Ind.) and the Hyogo Framework for Action (HFA) 2005–2015 were early efforts aimed at improving water resource management and reducing disaster losses. The National Plan for Disaster Management (NPDM) 2010–2014 and the National Action Plan on Disaster Risk Reduction (NAP-DRR) 2010–2012 further embedded these goals into national policy, emphasizing community engagement and coordination mechanisms. At the local level, the Disaster Management Plan of DKI Jakarta (DMP-DKI Jakarta) 2013–2017 and the Ciliwung Normalization Plan (CNP) focused on stakeholder participation, improving collaboration, and implementing structural modifications to reduce flood risks. Efforts to manage and mitigate flood risks in Jakarta have increasingly recognized the importance of collaboration between government agencies, non-governmental organizations (NGOs), and at-risk communities. Despite challenges in aligning cross-institutional objectives and strategies, initiatives have been undertaken to involve communities in flood risk management and decision-making processes. Addressing Jakarta's flooding issues requires a multifaceted approach, combining effective policy frameworks, infrastructure improvements, community engagement, and sustainable environmental practices. Flooding in Jakarta remains a complex and persistent challenge, necessitating continued efforts to enhance the city's resilience to future flood events. Problem Statement: The need for a comprehensive and collaborative approach to flood disaster mitigation. Objectives: To analyze the collaborative governance strategies in flood mitigation and their effectiveness in Jakarta.

2. Literature review

2.1. Collaborative governance

Collaborative governance has emerged as a critical approach in addressing complex urban challenges, such as flood disaster mitigation in Jakarta. This approach emphasizes the involvement of multiple stakeholders, including government agencies, private sectors, non-governmental organizations (NGOs), and local communities, working together to achieve shared goals (Rijal, 2023). In the context of flood disaster mitigation in Jakarta, collaborative governance facilitates the integration of various expertise, resources, and perspectives, which is essential given the city's recurring flood problems (Wicaksono and Herdiansyah, 2019). Studies have shown that effective collaborative governance can enhance disaster resilience by improving coordination, decision-making, and resource allocation among stakeholders (Chen and Li, 2020; Wang et al., 2022). For instance, Jakarta's flood management involves the collaboration of local governments, the National Disaster Management Agency (BNPB), and community-based organizations, which work together to implement flood control measures, early warning systems, and community education programs (Rochim et al., 2020). However, challenges such as bureaucratic inefficiencies, conflicting interests, and limited community participation often hinder the effectiveness of these collaborative efforts (Simanjuntak et al., 2012). To enhance the outcomes of collaborative governance in flood mitigation, there needs to be a focus on building trust among stakeholders, establishing clear communication channels, and fostering active community involvement (Hidayatullah et al., 2023; Ishiwatari, 2019). This approach not only helps in reducing the impacts of floods but also in creating a more adaptive and resilient urban environment.

The Jakarta Bay reclamation project and the giant flood wall provide examples of conflicting priorities and agendas that have sparked much debate among stakeholders (Garschagen et al., 2018). The Jakarta government believes that this project will benefit public safety and sustainable economic development in Jakarta, especially in preventing permanent flooding (Rudi, 2016) and improving water quality in Jakarta Bay (Wijaya, 2016). However, the National Disaster Management Agency has expressed concerns that this large project could worsen flooding in Jakarta because it could slow down water flow from the drainage system to the Jakarta Bay area (Lestari, 2016). Furthermore, the Ministry of Marine Affairs and Fisheries argues that this activity could potentially disrupt marine and coastal ecosystems and result in significant economic losses in the fisheries sector (Ramadhan et al., 2016). This fragmentation results from needing an institutional framework for collaboration between key stakeholders to build resilience (Djalante and Thomalla, 2012). A study has shown that organizational fragmentation is one of the 'institutional traps' that can challenge the resilience-building process (Lebel et al., 2011).

Multi-organizational cooperation in solving disaster problems has become a concern in disaster risk management issues (Hermansson, 2016; Htein et al., 2018; Sapat et al., 2019). In the past, disaster management used traditional approaches and hierarchical methods. In contrast to current approaches to traditional structures, they are less effective in dealing with various natural disasters and are faced with complex

problems (Bier, 2011; Klijn and Koppenjan, 2006; Kapucu et al., 2013). In emergencies, many aspects of a disaster are unpredictable and difficult to control, so various scholars and policymakers pay great attention to collaborative concepts for disaster management. Collaborative approaches have been proven feasible in overcoming disaster problems (Chen et al., 2020; Kapucu et al., 2013).

Solving disaster problems is very complicated when viewed from the perspective of just one organization. So that the concept of collaborative governance can observe disaster problems from various perspectives as an alternative solution to disaster problems, resolving disaster problems will feel complicated if it is done by more than one organization. So, collaboration has become the right choice when dealing with disasters (Waugh Jr. and Streib, 2006). A collaborative governance approach allows cross-institutions to join in solving disaster problems such as the central government, regional government, military, health workers and police (Robinson et al., 2013). After disaster management has been successfully resolved, cross-organizations will again build a cooperation system to maintain sustainable cooperation for Weber's preparedness (Weber, 2003). If conditions are not conducive, in the sense that one organization violates another organization, collaboration can occur that cannot continue in the long term (Hood, 2011; Lai and Hsu, 2019; Lim et al., 2016). Therefore, the collaborative governance approach of existing organizations will seek to build stronger relationships regarding resources to benefit the wider community (Provan and Milward, 2001).

Collaborative governance in flood disaster responses involves evolving networks among actors such as government, military, NGOs, and civil society. In Myanmar, these networks evolved based on social capital, transaction cost, homophily, and resource dependency theories. The governance system tends to form hierarchical structures rather than generalized exchanges, with reliance on diverse local actors emerging over time (Aung and Lim, 2021). Effective disaster management requires multi-layered leadership, including political, civilian, military, and community leadership. Comparative studies of the 2010 Haiti Earthquake and Pakistan Floods highlighted the critical role of military leadership and the challenges of weak political leadership and international coordination (Akbar and Aldrich, 2018).

2.2. Flood disaster mitigation

Flood disaster mitigation in DKI Jakarta is crucial due to the region's vulnerability to major floods, exacerbated by rapid urbanization, land subsidence, and climate change (Widodo and Permana, 2023). The literature highlights various structural and non-structural approaches implemented to address flood risks. Structural measures, such as the construction of dams, reservoirs, and flood control canals, such as the East Flood Canal, play an important role in diverting excess water flow from densely populated areas (Wijayanti et al., 2017). However, these measures are often inadequate due to increasing rainfall intensity and land subsidence, which reduce the effectiveness of flood infrastructure over time (Wang et al., 2018). Non-structural strategies, including developing early warning systems, community-based disaster risk reduction programs, and urban spatial planning reforms, enhance community resilience (Josè Moisès et al., 2023). In addition, the government has

launched initiatives such as the 'Jakarta Emergency Dredging Initiative' to improve the drainage system by removing sediment and waste from rivers and canals (Abidin et al., 2015; Marfai et al., 2015; Yuliadi et al., 2016). Despite these efforts, challenges remain due to the complex interactions between environmental, social, and governance factors (Dwirahmadi et al., 2023). Effective flood mitigation in Jakarta requires an integrated approach that combines technological advances, stakeholder collaboration, and proactive policy implementation to adapt to the evolving risk landscape (Sari and Anwar, 2021; Widiachristy and Rachmanto, 2021).

Floods have profound and wide-ranging impacts on health, economy, infrastructure, and the environment. Effective flood management and mitigation strategies are essential to minimize these devastating effects and enhance community resilience (Aldardasawi and Eren, 2021; Du et al., 2010; Mallett and Etzel, 2018; Pant et al., 2018). Structural measures, including dams, levees, and retention basins, are essential in mitigating flood risks (Abdi-Dehkordi et al., 2021; Chan et al., 2020; Finger et al., 2019; Peter and Fatuki, 2018). Their effectiveness is maximized when integrated with non-structural measures and adaptive management strategies. Combining these approaches ensures robust flood protection and community resilience. Dams are effective in reducing flood peaks and mitigating flood risks (Mei et al., 2017). However, they also pose significant ecological impacts and risks associated with potential dam failure (Hatchard et al., 2023). Comprehensive management strategies are essential to balance the benefits and mitigate the drawbacks of dam operations. Maintaining and upgrading levees are vital for coping with climate change-induced flood frequency and intensity (Miraee-Ashtiani et al., 2022). Regular maintenance, adaptive management, and integrated approaches are essential to ensure the effectiveness and resilience of levee systems in protecting communities and infrastructure (Morton and Olson, 2014). Well-planned retention basins are essential for reducing urban flooding and can provide significant community benefits when integrated with recreational spaces (Birkinshaw and Krivtsov, 2022).

Non-structural measures, including land use planning, early warning systems, and flood insurance, complement these physical defenses. Effective zoning and land use planning prevent construction in flood-prone areas, integrating flood risk assessments into urban planning reduces flood damage and supports sustainable development (Hemmati et al., 2021). Technological advancements have significantly improved early warning systems, The integration of remote sensing data and machine learning algorithms significantly enhances flood forecasting accuracy (Elkhrachy, 2022). Flood insurance is vital for managing financial risks from flooding (Kunreuther and Lyster, 2016). Public-private partnerships enhance coverage and affordability, making flood insurance accessible while promoting investments in mitigation measures (Crick et al., 2018). This integrated approach ensures comprehensive risk management and financial resilience.

Community engagement and education are also critical components of flood disaster mitigation. Public awareness campaigns are crucial in reducing the impact of floods by increasing preparedness and response capabilities (Maidl and Buchecker, 2015). Effective communication, community engagement, and tailored educational initiatives significantly enhance resilience to flood risks (Xie et al., 2023). Integrating local knowledge with scientific expertise in flood risk management projects ensures

contextually appropriate and effective mitigation strategies (Sharma, 2021). These projects demonstrate the value of combining different types of knowledge to enhance community resilience and improve flood risk management.

3. Research method

This research uses qualitative analysis with a content analysis approach (Graneheim et al., 2017; Bengtsson, 2016; Mayring, 2015). Several government websites and official educational institutions were used as sources of information to support this research. Official educational websites can provide insights into institutional identity, student representation, and educational practices (Lažetić, 2020). They contribute to scholarly communication and public relations, increasing the visibility of research findings (Feldy, 2015). Help interpret and synthesize research findings rigorously (Wolcott, 2002). This research also uses literature studies to support research discussions. This approach enhances the research narrative and aligns the literature with the study findings (Wolcott, 2002). Utilize publicly available policy document records, reports and statistical data provided by government institutions to ensure the credibility and reliability of sources. This research is a case study analysis of collaborative governance in handling Jakarta floods, with a focus on highlighting the effectiveness of collaborative governance in solving Jakarta flood problems. Below is a **Table 1** of relevant data sources referred to in this research;

Table 1. References on flood mitigation efforts in Jakarta.

No	Document	Sumber
1.	Flood Governance in Jakarta: The Role of CBOs in Mitigating Annual Floods | Middle East Institute	https://www.mei.edu/publications/flood-governance-jakarta-role-cbos-mitigating-annual-floods
2.	Why Jakarta Often Experiences Floods and How Adapting Nature-based Solutions (NbS) can Help Reduce the Risk	https://wri-indonesia.org/id/wawasan/mengapa-jakarta-sering-mengalami-banjir-dan-bagaimana-adaptasi-nature-based-solutions-nbs
3.	World Bank Supports Flood Mitigation Efforts in Jakarta	https://www.worldbank.org/en/news/press-release/2012/01/17/world_bank_supportsfloodmitigationeffortsinjakarta

Data analysis is an essential process in decision-making based on valid and accurate data (Devine et al., 2004; Grosof and Sardy, 1985; Roychowdhury and Bhattacharya, 2018; Sun, 2021). Reliable data sources, such as official websites and official online documents, play a crucial role in this process (Ayuningtyas et al., 2023; Rabcan et al., 2019). Data obtained from official sites, such as government reports and official agency statistics, provide high credibility and relevance because they follow recognized and verified standards (Rabcan et al., 2019; Sun, 2021). Using data from these sources allows for more in-depth and accountable analysis because the information used has been validated and meets publication ethics standards (Devine et al., 2004; Rabcan et al., 2019). Thus, integrating data from official sources into the analysis helps ensure that the results obtained are accurate and can support better decision-making in various contexts, both in the public and private sectors (Roychowdhury and Bhattacharya, 2018).

This study uses several online news media as a source of reference data, as listed in **Table 2**, using the keywords "flood mitigation" and "DKI Jakarta" "As many as ten selected news pages were then exported to the Nvivo 12 Plus application using the Ncapture tool on Google Chrome. Online news media can be used as a valid reference for research data sources (Lecheler and Kruikemeier, 2015; Kousha and Thelwall, 2017) NVivo 12 plus software is often used in viewing policy narratives by stakeholders in the policy process (Amri et al., 2022; Salahudin et al., 2020) The data processing results show significant findings about the efforts of the DKI Jakarta government in flood mitigation. Furthermore, it shows several stakeholder actors who provide important narratives, as in **Table 2** and **Figure 1**.

Table 2. Stakeholders of the DKI Jakarta government.

No	Stakeholders	Institution	Media
1	Adrian Mara Maulana	(Head of North Jakarta SDA Sub-Department)	Tempo.com
2	Ahmad Riza Patria	(Deputy Governor of DKI Jakarta)	BeritaJakarta.id
3	Anies Baswedan	(Governor of DKI Jakarta)	Antara.com
4	Ika Agustin Ningrum	(Acting (Plt.) Head of DSDA DKI Jakarta Province)	Bisnis.com
5	Joko Widodo	(President of the Republic of Indonesia)	Detik.com
6	Purwanti Suryandari	(Head of the West Jakarta Water Resources (SDA) Sub-dept.)	Kompas.com
7	Tjahyono Budi Setiawan	(Head of the Natural Resources Implementation Unit (Kasatpel) for Cilincing District)	Tribunjakarta

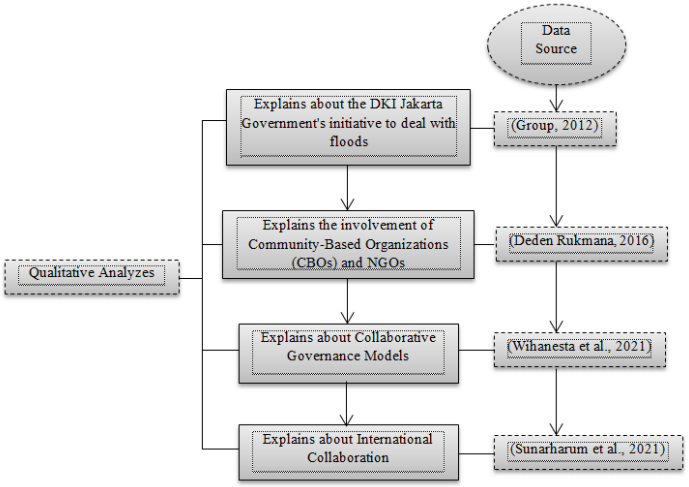

Figure 1. Research framework.

The research framework illustrated in the image focuses on analyzing the DKI Jakarta Government's initiatives to manage floods, with an emphasis on collaborative efforts involving various organizations. The data sources for this analysis include studies by Group (2012), Deden Rukmana (2016), Wihanesta et al. (2021) and Sunarharum et al. (2021). The core method used for this research is qualitative analysis, which involves a detailed and interpretive examination of the data. The analysis begins with an explanation of the initiatives taken by the DKI Jakarta Government to address

flood issues. This foundational step sets the stage for understanding the broader context of flood management in the region. Following this, the framework delves into the involvement of community-based organizations (CBOs) and non-governmental organizations (NGOs) in these flood management efforts. This step highlights the crucial role these organizations play in supporting and supplementing government initiatives. The next phase of the analysis explores collaborative governance models. This involves examining the partnerships and cooperation between the government, CBOs, NGOs, and potentially other stakeholders in managing floods. By understanding these governance models, the research aims to shed light on effective strategies for collaborative flood management. Finally, the framework addresses international collaboration efforts. This involves analyzing partnerships, support, and knowledge exchange with international organizations and other countries. The aim is to understand how global collaboration can enhance local flood management practices.

4. Result

4.1. DKI Jakarta government's initiative to deal with floods

The Jakarta provincial government has implemented several key projects aimed at reducing flood risks. These include the Jakarta Urgent Flood Mitigation Project (JUFMP), which is supported by the World Bank. This project involves dredging waterways, rehabilitating embankments, and installing pumps to improve the city's flood management infrastructure. The project is financed through a combination of loans and government funds, with a strong emphasis on environmental and social safeguards (International Water Power). **Figure 2** below shows data on the components of the Jakarta urgent flood mitigation project.

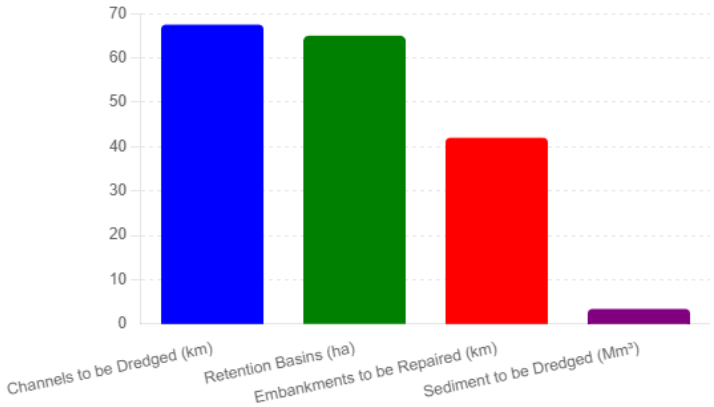

Figure 2. Components of the Jakarta urgent flood mitigation project.
Source: (Group, 2012).

The data shows that the largest component of the project involves dredging approximately 65 km of channels, depicted by the blue bar. This indicates a significant effort to clear waterways and improve water flow, essential for reducing flood risks. The green bar represents the creation of around 60 hectares of retention basins, which are crucial for holding excess water during heavy rains to prevent flooding. The red bar shows that about 40 km of embankments need repair, highlighting the importance of maintaining and enhancing the structural integrity of existing flood defenses. Lastly,

the purple bar indicates the need to dredge approximately 5 million cubic meters of sediment from waterways, ensuring their capacity and flow efficiency are maintained. Overall, the chart emphasizes the comprehensive approach of the Jakarta Urgent Flood Mitigation Project, focusing on significant dredging activities, the creation of retention basins, the repair of critical embankments, and the removal of obstructive sediments from waterways. These efforts collectively aim to enhance Jakarta's flood management infrastructure and mitigate the impact of flooding in the city.

The data presented in the chart highlights the multifaceted approach taken by the Jakarta Urgent Flood Mitigation Project, with each component playing a crucial role in addressing the city's flood risks. The largest component, involving the dredging of approximately 65 km of channels, underscores the extensive efforts to clear waterways and enhance water flow. This is a fundamental step in reducing flood risks, as clogged or narrow channels can significantly impede the flow of water, leading to overflow and flooding during heavy rains. The creation of around 60 hectares of retention basins, as depicted by the green bar, is another critical aspect of the project. Retention basins serve as temporary storage for excess water, preventing it from overwhelming the city's drainage systems and reducing the likelihood of urban flooding. This component is particularly important in a city like Jakarta, which experiences frequent and intense rainfall. Repairing about 40 km of embankments, highlighted by the red bar, emphasizes the need for maintaining and enhancing the existing flood defenses. Embankments play a vital role in protecting low-lying areas from floodwaters, and their deterioration can compromise the overall flood management strategy. Repairing these embankments ensures they remain effective barriers against flooding. Lastly, the need to dredge approximately 5 million cubic meters of sediment, shown by the purple bar, highlights the importance of maintaining the capacity and flow efficiency of waterways. Sediment buildup can reduce the depth and width of channels, restricting water flow and increasing the risk of flooding. Removing this sediment helps to restore the full capacity of the waterways, allowing them to handle larger volumes of water. **Figure 3** below shows data on financial contributions to Jakarta's urgent flood mitigation project.

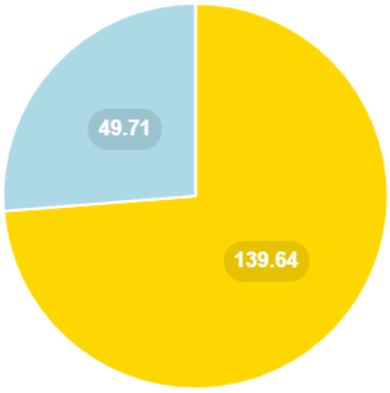

Figure 3. Financial contributions for Jakarta urgent flood mitigation project.
Source: (Group, 2012).

The pie chart illustrates the financial contributions for the Jakarta Urgent Flood Mitigation Project, segmented into two distinct portions. The first segment, represented in light blue, signifies a contribution of 49.71 units. This segment accounts

for approximately 26.26% of the total funding. In contrast, the second segment, shown in yellow, represents a significantly larger contribution of 139.64 units, making up approximately 73.74% of the total contributions. The stark difference between the two segments highlights that the majority of the project's funding comes from the source represented by the yellow segment, with the light blue segment contributing a smaller yet still substantial portion. This distribution indicates a predominant reliance on one major funding source while still acknowledging the importance of the secondary contribution.

Flood management in DKI Jakarta is a top priority for various government, private, and community stakeholders. The responses from these stakeholders reflect their strategic roles in facing the challenges of flooding that often hit the capital city. The DKI Jakarta government, through various policies and initiatives, focuses on structural approaches such as river normalization, reservoir construction, and installation of water pumps to control excessive water flow. The following **Figure 4** are the results of coding the opinions of various stakeholders regarding government initiatives in flood management.

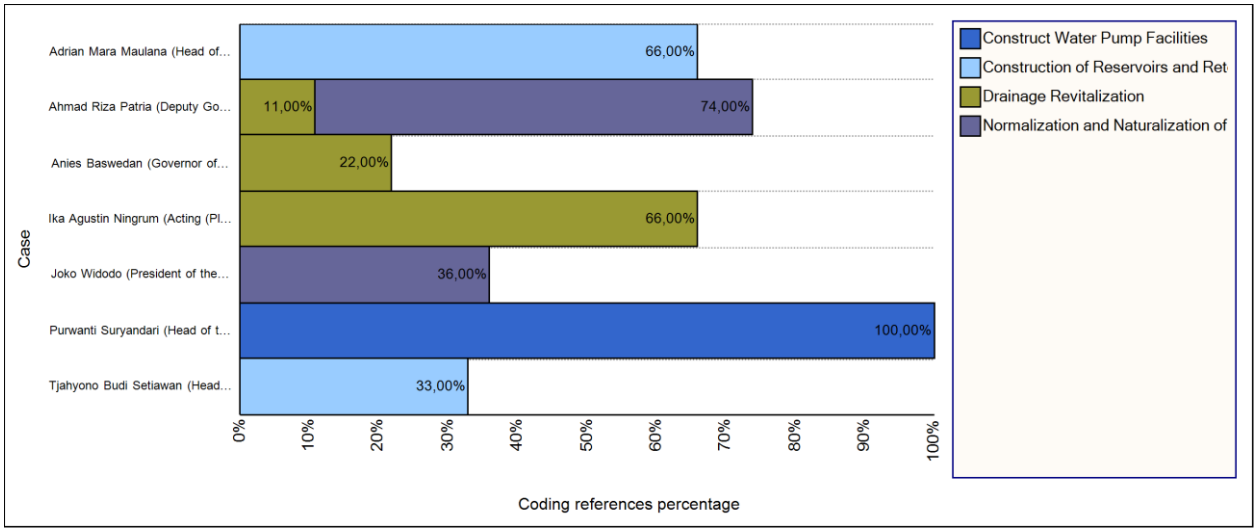

Figure 4. Stakeholder narrative in online news media.
Source: Processed results of Nvivo 12 Plus Software (2024).

The figure above shows the distribution of various flood management strategies implemented in Jakarta, highlighting the contributions of various policy actors. These strategies include the construction of water pumping facilities, the construction of reservoirs and retention ponds, the revitalization of drainage systems, and the normalization and naturalization of rivers. Actor Purwanti Suryandari, as the Head of the Water Resources Department, strongly focuses on the construction of water pumping facilities, with 100% of her initiatives directed towards this strategy, indicating her primary approach to flood mitigation. Tjahyono Budi Setiawan and Adrian Mara Maulana are prominently associated with constructing reservoirs and retention ponds, emphasizing the importance of water storage solutions, with Tjahyono contributing 33% and Adrian contributing 66% in this area. Ika Agustin Ningrum (66%) significantly championed drainage revitalization efforts and highlighted her commitment to improving urban drainage systems to prevent flooding.

Anies Baswedan contributed to this strategy, albeit to a lesser extent (22%), indicating a diverse approach in his flood management policies. River normalization and naturalization are most prominently associated with Ahmad Riza Patria (74%) and Joko Widodo (36%), reflecting a strategic focus on improving river conditions to manage water flow effectively. Each policy actor in DKI Jakarta provides different arguments but with the same goal of overcoming flooding in DKI Jakarta. The involvement of various policy actors in various fields demonstrates a multi-faceted strategy that addresses not only immediate flood mitigation but also long-term resilience building, reflecting the government's commitment to sustainable flood management (Sett and Sandholz, 2020).

4.2. Community-Based Organizations (CBOs) and NGOs

Community-based organizations and NGOs play a crucial role in flood mitigation by engaging with local residents and facilitating community participation. For instance, Ciliwung Merdeka has been instrumental in resettling riverbank residents, promoting trash management, and advocating for green space development. These organizations hold regular meetings with residents to discuss flood mitigation strategies and work closely with the government to implement community-led initiatives (Middle East Institute). **Figure 5** below shows data on crucial NGOs involved in flood mitigation efforts in Jakarta.

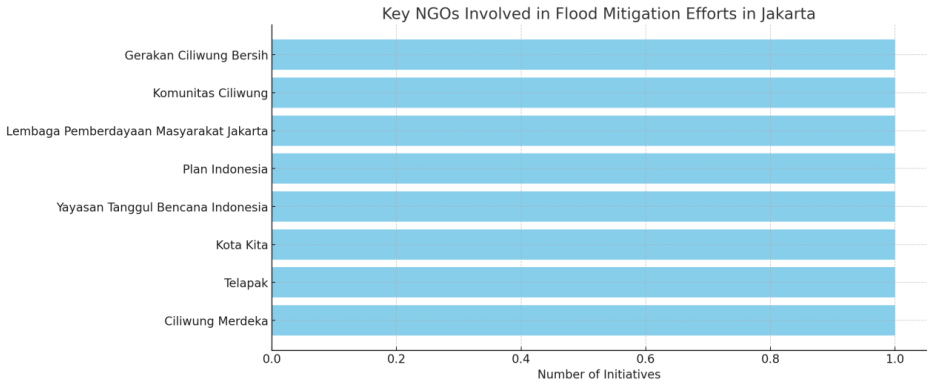

Figure 5. Key NGOs involved in flood mitigation efforts in Jakarta.
Source: (Deden Rukmana, 2016).

The bar chart shows key NGOs involved in flood mitigation efforts in Jakarta, emphasizing that each organization has contributed equally to these initiatives. In particular, the chart highlights the uniformity of participation of the following NGOs: Gerakan Ciliwung Bersih, Komunitas Ciliwung, Lembaga Pemberdayaan Masyarakat Jakarta, Plan Indonesia, Yayasan Tanggul Bencana Indonesia, Kota Kita, Telapak, and Ciliwung Merdeka. Each organization is shown to have participated in one initiative, as indicated by the equal length of the horizontal lines. This equal participation underscores the coordinated and collective efforts among these NGOs to address flooding in Jakarta, illustrating their shared commitment and responsibility in addressing this critical environmental challenge. the role of NGOs, disaster risk reduction, and climate change adaptation efforts in building flood resilience in Jakarta, emphasizing the importance of coordinated action among various stakeholders,

including NGOs (Dwirahmadi et al., 2019; Pramono, 2021; Sohrabizadeh et al., 2023). **Figure 6** below shows data on the roles and activities of NGOs in flood mitigation.

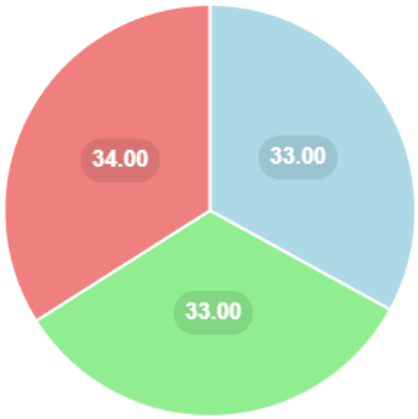

Figure 6. Roles and activities distribution of NGOs in flood mitigation.
Source: (Deden Rukmana, 2016).

The chart illustrates the roles and activities of NGOs in flood mitigation, divided into three segments with nearly equal contributions. The red segment, representing 34.00 units, accounts for slightly more than one-third of the total contributions at approximately 34%. The blue and green segments, representing 33.00 units, account for slightly less than one-third of the total, at approximately 33% each. This balanced distribution highlights the collaborative and comprehensive approach taken by the NGOs in addressing flood mitigation. The slight variation in the red segment's contribution indicates a marginally higher involvement or number of activities than the blue and green segments. The role of NGOs in flood management in DKI Jakarta is very diverse and important in filling gaps that cannot be fully addressed by the government (Yoga Putra et al., 2019). Through participatory, collaborative, and community-based approaches, NGOs make significant contributions in reducing the impact of flooding, increasing public awareness, and encouraging sustainable environmental policies (Pramono, 2021). The distribution of activities covering education, environmental rehabilitation, advocacy, disaster management, and community empowerment demonstrates the holistic approach needed for effective flood management (Lassa et al., 2023).

4.3. Collaborative governance models

The integration of Nature-based Solutions (NbS) is another collaborative approach being adopted. This involves combining traditional grey infrastructure with green infrastructure to enhance flood resilience. The Jakarta government has started implementing NbS through interventions such as expanding green open spaces, creating vertical drainage systems, and constructing biopore infiltration holes (WRI Indonesia). **Figure 7** below shows data on the land cover map of the region before and after land use changes.

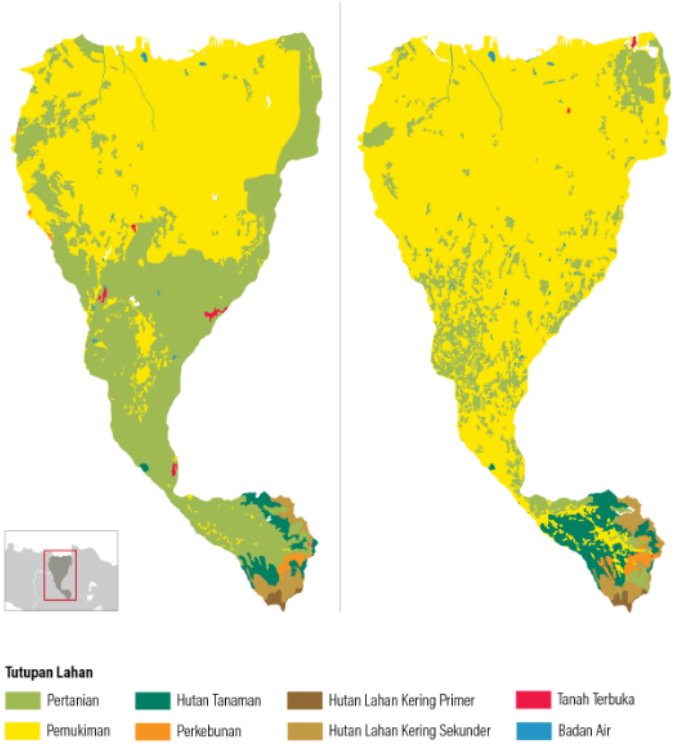

Figure 7. Land cover map of region before and after land use changes.
Source: (Wihanesta et al., 2021).

The maps illustrate the land cover of a region across two different time periods, showcasing various categories of land use. These categories include agriculture shown in light green, settlements in red, plantations in dark green, forest plantations in medium green, primary dryland forest in dark brown, secondary dryland forest in light brown, open land in pink, and water bodies in blue. A comparison of the two maps reveals significant insights into how land cover has changed over time. Agricultural areas, which dominate both maps, indicate the region's reliance on farming. Urban areas remain relatively small, with minimal growth or new development. The extent of plantations and forest plantations has changed, potentially indicating either an increase in plantation agriculture or changes in forest management practices. Primary and secondary dryland forests show variations that could suggest deforestation or regrowth. Open lands, depicted in pink, highlight non-vegetated areas that may have altered due to natural or human activities. Water bodies appear consistent, although slight changes suggest fluctuations in water levels or the creation of new water bodies.

The increasing number of settlements and plantations shown on the map reflects economic growth but also raises concerns about deforestation and reduced natural water absorption, which can exacerbate flood risks (Merten et al., 2020). Collaborative governance plays a critical role here by encouraging dialogue among stakeholders to develop integrated land-use plans that promote sustainable practices, reforestation, and conservation efforts, especially in primary and secondary forest areas (Davis et al., 2017; Tando and Haryanti, 2022). Effective flood management in these diverse land-use zones requires multi-stakeholder engagement, with environmental agencies, communities, and industry participating in joint decision-making to implement flood

control measures, such as restoring natural water retention areas and improving drainage in agricultural zones (Sarmiento Barletti et al., 2020).

4.4. International collaboration

International collaboration also plays a vital role. The World Bank and other international organizations provide financial and technical support to Jakarta's flood mitigation efforts. These partnerships help Jakarta implement advanced flood management systems and improve the city's overall resilience to natural disasters (International Water Power) (SpringerLink). In summary, effective flood mitigation in Jakarta requires a multifaceted approach involving government initiatives, community engagement, and international support. This collaborative governance model aims to build a more resilient and sustainable urban environment. **Figure 8** below shows data on the timeline of policy frameworks relevant to disaster risk reduction in Jakarta.

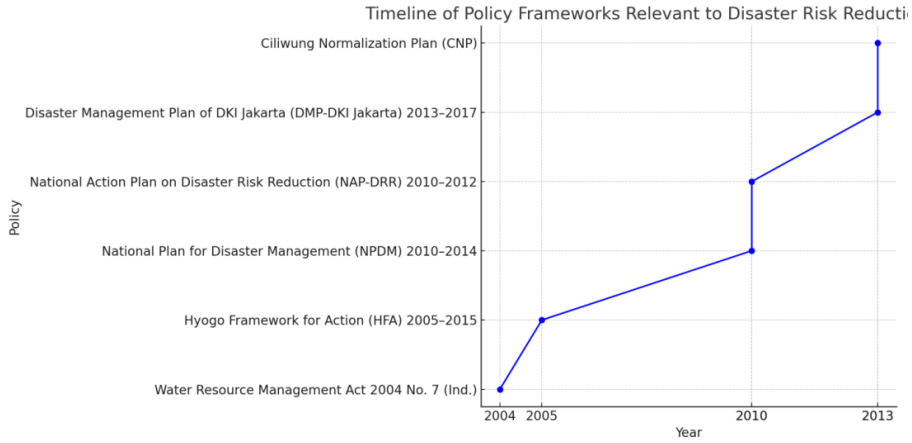

Figure 8. Timeline of policy frameworks relevant to disaster risk reduction in Jakarta.

Source: (Sunarharum et al., 2021).

The chart presents a timeline of policy frameworks relevant to disaster risk reduction in Jakarta from 2004 to 2017. It begins with the Water Resource Management Act 2004 No. 7, which was introduced in 2004 as the earliest policy in the timeline, focusing on sustainable water use and flood risk mitigation. The Hyogo Framework for Action (HFA) was adopted in 2005, marking a global initiative aimed at building resilience and reducing disaster risks with strategic goals and priorities. In 2010, the National Action Plan on Disaster Risk Reduction (NAP-DRR) and the National Plan for Disaster Management (NPDM) were implemented, focusing on reducing disaster risks at the national level and providing a comprehensive framework for disaster management, respectively. These plans, spanning from 2010 to 2012 and 2010 to 2014, emphasize preparedness, response, and recovery efforts.

The Disaster Management Plan of DKI Jakarta (DMP-DKI Jakarta), implemented from 2013 to 2017, is a specific plan for Jakarta, addressing the region's unique challenges with tailored strategies and actions. The timeline peaks with the Ciliwung Normalization Plan (CNP), the latest initiative to normalize the Ciliwung River through infrastructure improvements and river management to reduce flooding.

This timeline shows a clear progression of increasingly targeted and comprehensive policies introduced over the years to address disaster risk reduction in Jakarta. Early initiatives laid the groundwork for subsequent, more localized plans, while national plans in 2010 signified a strategic shift towards a structured approach to disaster risk management. The Disaster Management Plan of DKI Jakarta and the Ciliwung Normalization Plan represent focused efforts to tackle specific regional challenges, highlighting the evolving understanding and response to flood risks in Jakarta. The progression underscores the importance of continual policy development and implementation to manage and reduce disaster risks in this flood-prone region effectively. The incorporation of global frameworks like the HFA into national and local policies underscores the critical role of international cooperation in enhancing disaster resilience (Shah et al., 2020). By aligning with international standards, Indonesia has been able to develop comprehensive disaster management strategies that address both national and local challenges, demonstrating the value of global partnerships in disaster risk reduction efforts (Saputra et al., 2023).

5. Discussion

The collaboration among different stakeholders in Jakarta has significantly improved flood mitigation efforts through a comprehensive and multifaceted approach. effective collaboration among different government levels and institutions is key to managing floods more efficiently (Rahmayanti, 2021). The Jakarta government, in collaboration with the Ministry of Public Works and Housing, has undertaken extensive dredging projects and improved canals and riverbanks to increase the capacity of waterways to handle heavy rainfall. Additionally, sophisticated early warning systems have been implemented to provide timely alerts to residents about impending floods, developed in partnership with meteorological agencies and technological firms. Public-private partnerships (PPP) have played a crucial role in constructing critical infrastructure such as retention basins, pump stations, and floodgates, funded through PPP agreements ensuring better design, maintenance, and operational efficiency. a project linked multiple pumping stations with the city's main rainwater pipeline, improving flood control by utilizing existing infrastructure more effectively and incorporating privately owned land for additional rainwater storage (Hayakawa et al., 2021). Moreover, private tech firms have collaborated with the Jakarta government to deploy smart city solutions that monitor weather patterns, water levels, and drainage systems in real-time, allowing for quicker response and management. the deployment of smart water-level sensors at optimal locations helps in making informed decisions for managing hydrological infrastructure such as drainage channels and floodgates. This approach ensures the data is most relevant for flood control (Ogie et al., 2017). Community engagement has also been pivotal, with NGOs and community organizations working with local governments to educate the public about flood risks and preparedness through awareness and education programs. NGOs play a crucial role in bridging these gaps by tailoring solutions to community needs and raising awareness (Shah et al., 2023). Community-based volunteer networks, supported by both governmental and non-governmental organizations, assist in evacuation, distribution of aid, and post-flood recovery efforts during flood events.

The collaborative efforts among disaster organizations, volunteers, and the community are vital for effective disaster management (Chan et al., 2019).

International cooperation has further bolstered Jakarta's flood mitigation efforts through funding and technical assistance from countries like the Netherlands, Japan, and organizations like the World Bank. These collaborations have brought in expertise in water management, engineering solutions, and financial support for large-scale projects. These projects involve multiple stakeholders and address complex contamination and stressor exposures, ensuring sustainable water management (Brack et al., 2019). Joint research initiatives with international universities and research institutions have led to the development of innovative flood management practices and technologies tailored to Jakarta's unique challenges. integrates research, education, and practical applications to mitigate water-related issues, which can serve as a model for Jakarta (Sumi et al., 2013).

Innovative engineering solutions, such as green infrastructure and climate-resilient urban planning, have been promoted through collaborations with environmental groups and urban planners. Co-design processes in urban planning, involving diverse stakeholders, can lead to more inclusive and effective nature-based solutions (NBS) and ecosystem services, addressing both social and environmental justice (Basnou et al., 2020). These initiatives include the restoration of wetlands and the creation of urban green spaces that can absorb excess rainwater. Successful urban wetland projects prioritize wetland functions and values over vegetation structure to provide ecological benefits and urban amenities (Ravit et al., 2017). Integrated urban planning considers flood risks in new developments, with zoning regulations preventing construction in high-risk flood zones and ensuring that buildings are resilient to flooding. This approach helps optimize human settlements and mitigate flood risk through strategic planning and collaborative management (Yang et al., 2022).

The legal and regulatory framework has been strengthened through effective collaboration. Collaboration can improve the rule of law by increasing predictability, accessibility, supremacy and equality before the law (Qi, 2019). stricter regulations regarding waste management and building regulations, which are crucial in preventing blockages in drainage systems and ensuring that buildings are built to withstand flooding. Existing building drainage system design guides are outdated and need to be revised to cater to modern tall buildings. Updated regulations are required to address the specific drainage needs of tall buildings to prevent system failures and public health risks (Gormley et al., 2021). Coordinated efforts in land use planning have incorporated flood risk assessments into urban development plans, helping to reduce the impact of flooding on residential and commercial areas.

The impact of these collaborative efforts is evident in the reduced frequency and severity of floods in Jakarta. Strategies that combine on-site and off-site programs have been implemented to reduce the magnitude and frequency of flooding. This approach addresses both immediate and long-term flood risks through comprehensive management of the Ciliwung watershed (Asdak et al., 2018). Strategic risk communication by the Regional Disaster Management Agency (BPBD DKI Jakarta) has been critical in educating residents about flood risks and preparedness measures. This effort has contributed to more effective community responses and reduced flood

impacts (Susilowardhani et al., 2018). Improved infrastructure and proactive management have minimized the impact of heavy rainfall events, enhancing the city's overall resilience to flooding. Effective management of stormwater and urban temperatures reduces the overall risk of flooding (Richards and Edwards, 2018). Communities are better prepared, and infrastructure is more robust, capable of handling extreme weather events. Developing innovative technologies and robust government regulations are crucial for making societies more resilient to extreme events (Kythreotis et al., 2013). The adoption of sustainable practices, such as green infrastructure and climate-resilient urban planning, ensures that flood mitigation efforts are long-term and environmentally friendly. Modern urban planning now emphasizes integrated blue-green infrastructure, aiming to harmonize human habitation with water cycles (Alshaikh et al., 2023). In summary, the collaboration among various stakeholders has been instrumental in advancing flood mitigation in Jakarta, resulting in significant improvements in infrastructure, early warning systems, community preparedness, and sustainable urban planning.

Despite significant progress in flood mitigation through stakeholder collaboration in Jakarta, several challenges and limitations persist. Fragmented coordination among multiple agencies and organizations often leads to inefficiencies and miscommunication, as there is a lack of a centralized coordinating body to streamline efforts. In crisis management, fragmented coordination is often inevitable but can be managed through practices like working around procedures, delegating tasks, and demarcating expertise. These practices can help deal with ambiguity and discontinuity in fast-response situations (Wolbers et al., 2017). Resource constraints, both financial and human, can hamper the execution of large-scale infrastructure projects and the maintenance of existing systems. Financial constraints can lead to the abandonment of innovation projects, especially during the early stages (Segarra-Blasco et al., 2013)

To overcome these challenges, establishing a centralized coordinating body dedicated to flood management can streamline efforts and improve communication among stakeholders. Effective facilitation and coordination among stakeholders are essential for the success of these local organizations, particularly in larger areas where co-management bodies play a key role in effective coordination (Sultana and Thompson, 2010). Securing additional funding through government budgets, international aid, and private sector investment is crucial. These mechanisms ensure a consistent flow of funds for flood mitigation, reducing the long-term damage and increasing resilience (Ishiwatari and Sasaki, 2022). Public-private partnerships can help share the financial burden and bring in expertise and innovation. These strategies include effective communication, legal coordination, and consistent funding, which are critical for successful PPP implementation (Osei-Kyei et al., 2023). Providing training and capacity-building programs for government officials, community leaders, and technical personnel can enhance the implementation and maintenance of flood mitigation systems. significant support among professionals for developing local community capacity to reduce disaster impacts through education and training (Yakubu et al., 2022). Encouraging knowledge transfer from international experts can also be beneficial. This approach facilitated knowledge exchange and improved flood-related decision-making (Stokes et al., 2015).

Flood disaster mitigation requires a coordinated effort among various stakeholders, including government agencies, local communities, the private sector, NGOs, and international organizations (Basuki et al., 2022; Isa et al., 2019). Government agencies should focus on implementing integrated water management strategies, enhancing early warning systems, and enforcing zoning laws that restrict construction in flood-prone areas (Islam et al., 2016; Riza et al., 2020). By investing in green infrastructure, such as permeable pavements and rain gardens, governments can improve water absorption and reduce surface runoff (Sharma and Malaviya, 2021). Additionally, governments should promote policies that incentivize flood-resistant building designs to ensure sustainable urban development (Kretschmer et al., 2021; Oneto and Canepa, 2023).

6. Conclusion

Collaboration between stakeholders in Jakarta has significantly improved flood mitigation through a comprehensive and multifaceted approach. Effective collaboration between different levels of government and institutions is essential for efficient flood management, as demonstrated by the Jakarta government's partnership with the Ministry of Public Works and Housing in extensive canal dredging and improvement. The implementation of sophisticated early warning systems, supported by the meteorological agency and technology companies, and critical infrastructure funded through public-private partnerships (PPPs), such as retention ponds and pumping stations, have been critical. Integrating multiple pumping stations with the city's stormwater pipeline network has optimized flood control, leveraging existing infrastructure and privately owned land. Innovative city solutions, developed with private technology companies, have enabled real-time monitoring and management of weather patterns and air heights. At the same time, community engagement through NGOs and volunteer networks has strengthened public education and flood response efforts. International cooperation has been provided through financial support experts in flood management. Collaborative initiatives have promoted green infrastructure and climate-resilient urban planning by incorporating flood risk assessments into city development to mitigate the impacts of flooding. Strengthened legal and regulatory frameworks, alongside coordinated land-use planning, have improved infrastructure and community resilience. Despite recent progress, challenges such as fragmented coordination and resource constraints persist, highlighting the need for a consistent coordinating body and funding. Establishing mechanisms and encouraging knowledge transfer can enhance flood mitigation efforts, ensuring long-term sustainability and resilience. Theoretically, this study contributes to understanding collaborative governance in urban flood management, illustrating how multi-stakeholder partnerships and integrated planning can effectively mitigate environmental risks.

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