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Financing Flood Protection in Archipelagic Asia: A Comparative Analysis of Indonesia, Japan, and the Philippines

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ABSTRACT

Flood-prone countries need to invest in flood protection measures to safeguard populations and economic assets in an era of climate change and societal transformation. This study aims to propose policies and approaches to financial mobilization for flood protection. It examines flood protection investments and resulting damage in Indonesia, Japan, and the Philippines over the past two decades. While various financing mechanisms have been proposed for disaster risk reduction, empirical analysis of cost-sharing policies using actual budget and damage data remains limited. Through analysis of budget allocation trends, damage patterns, and financing mechanisms, this research reveals varying approaches to flood protection investment and their effectiveness. The study highlights the importance of cost-sharing among national governments, local governments, and local communities, offering insights into effective strategies for flood risk management in diverse economic and geographical contexts. Key findings indicate that the Philippines has increased investment following major disasters as predicted by earlier models, while Indonesia has not consistently increased budgets despite economic growth. Japan shows a recent increase after a period of decline. Policy recommendations include implementing cost-sharing mechanisms, providing financial incentives for local governments, and enhancing community engagement.

KEYWORDS: cost-sharing, financial mechanism, disaster risk reduction, climate change adaptation

1 INTRODUCTION[1]

Flood protection remains a critical issue for many countries as climate change increases the frequency and intensity of extreme weather events (Wasko et al. 2021). In particular, developing countries that are experiencing urbanisation and development need to invest effectively in flood protection measures to safeguard populations and economic assets. (Dottore et al. 2023; Rentscheler et al 2022).

The study aims to identify effective strategies and potential areas for improvement in flood risk management by comparing approaches to flood protection investments and resulting flood damages. It focuses on three archipelago countries in the Asian monsoon area with significant flood risks: Indonesia,

[1] The contents of this paper were released in JICA Ogata Research Instituter Discussion Paper "Flood Protection Investments in Indonesia, Japan, and the Philippines: A Comparative Analysis" (Ishiwatari and Kawasaki, 2025)

Japan, and the Philippines. These nations share common challenges related to their geographical characteristics—extensive coastlines, densely populated low-lying areas, and exposure to typhoons and monsoon rainfall. The diverse economic and geographic characteristics provide a rich context for understanding the challenges and opportunities associated with investing in flood protection.

2 MOBILIZING FINANCING FOR FLOOD PROTECTION

This section revies recent studies, focusing on the challenges of maintaining long-term investment, the potential of various funding sources and innovative financing strategies. There is limited literature examining practical data on investment and damage or cost-sharing policies between different levels of government.

Research has shown that while national authorities often increase flood protection funding in the aftermath of major flood events, maintaining high levels of investment over time proves challenging. Ishiwatari and Sasaki (2022) identified cyclical patterns in flood protection investments, where the ratios of flood budgets and damages to GDP form distinct investment cycles. They observed five such cycles in Japan over almost 150 years. This cyclical nature highlights the need for strategies to sustain funding beyond immediate post-disaster periods.

Recent trends point towards a more diverse approach to flood protection financing. Driessen et al. (2018) noted an increasing involvement of local governments, private companies including insurance firms, municipalities, and property owners in flood protection efforts. This expands financial resources, allows for a community-based approach, and strengthens capacity to prepare for and respond to disasters. The challenge, however, is that financial resources and expertise are not always available at the community level.

Various financing mechanisms have been proposed for disaster risk reduction and climate change adaptation. Kunreuther and Linnerooth-Bayer (2003) studied pre-disaster hedging instruments such as insurance and catastrophe bonds in emerging economies, finding that these instruments can effectively channel funds from international capital markets to support post-disaster recovery. Brugmann (2012) proposed a paradigm shift in viewing investments in disaster risk reduction and climate change adaptation, arguing that investing in resilience can increase investment returns and confidence in asset values. Kok et al. (2021) proposed mechanisms for leveraging public investments in nature-based flood defense projects through value capture and co-investment approaches.

Most existing research focuses on theoretical frameworks or case studies of individual countries, with limited comparative analysis using actual budget allocation and damage data across multiple nations. This study addresses this gap by analysing practical investment data and financing mechanisms in three countries over two decades.

3 METHODOLOGY

This study utilizes a mixed-methods approach, combining quantitative analysis of historical data with qualitative assessment of policy documents and expert interviews. Data collection involved gathering budgetary and damage data from government statistics, the EM-DAT database, and interviews with officials and experts. Semi-structured interviews were conducted with Indonesian officers in January and June 2024, Filipino officers in March 2024, and experts in international organizations and aid agencies.

The budget data includes expenditure on flood, landslide and coastal hazard protection works. There is no common definition of flood protection budgets among the three countries, and the data are not clearly differentiated. Japanese data include local government budgets, whereas Indonesian and Philippine data primarily reflect national government spending. Budget data from the Indonesian provinces of Jakarta, West Java and Bandung were collected to understand local government investment. The difficulty of collecting standardised data is a limitation of budget analysis studies in disaster risk reduction.

To ensure comparability across different economies and time periods, all financial data has been converted to 2015 USD. Analysis considers both absolute values and percentages of GDP to account for economic differences between countries.

4 RESULTS

This section examines investments in flood protection and flood damage in three countries (Table 1). Indonesia has not increased its budget as a percentage of GDP. The Philippines increased its budget following major disasters. Japan decreased its budget due to a stagnating economy but started to increase it again after a series of disasters.

Table 1. Summary of Flood Protection Investment Characteristics

Indicator	Indonesia	Philippines	Japan
Avg. Annual Damage	~$500M (0.06% GDP)	~$670M (0.3% GDP)	<0.2% GDP
Budget Trend	Stagnant (0.03-0.07%)	Increasing (0.3→0.7%)	Recovering (0.9→0.3→0.5%)

4.1 Indonesia

Indonesia comprises over 17,000 islands stretching along the equator with a population exceeding 270 million. The country's major cities, including the Jakarta metropolitan area, were developed in low-lying coastal areas, making them particularly vulnerable to flooding from both heavy rainfall and sea-level rise.

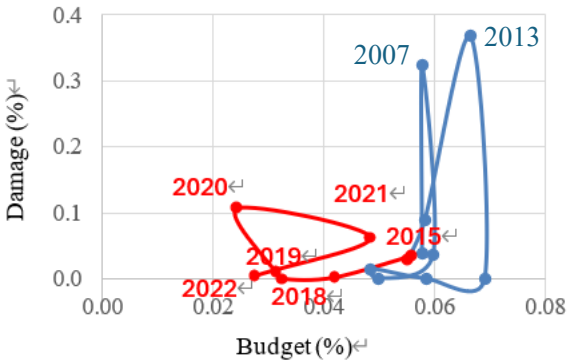

Figure 1 Flood protection budget and flood damage in Indonesia (Ratio to GDP)

Damage: From 2006 to 2023, the country suffered flood damages amounting to USD 8.6 billion in 2015 prices, averaging about USD 500 million per year (0.06% of GDP) (Figure 1). Damage in Jakarta is increasing because of population migration, climate change, land subsidence, and land use change (Budiyono et al. 2016). The 2007 flood inundated 340,000 people in 35% of the city and closed the Jakarta international airport for three days (World Bank 2019). The 2013 flood damaged the capital region with about USD 3 billion (0.37% of GDP), and the 2020 flood caused USD 1.2 billion in damage (0.11% of GDP).

Investment: Flood protection budgets of the Ministry of Public Works and Housing (MPWH) have varied over time, often fluctuating rather than consistently increasing. The budget was around 300 million USD in 2015 prices until 2010, increasing 260-570 million USD from 2010 to 2022. Over nearly two decades, the budget remained in the range of 0.03-0.07% of GDP (Figure1). The budgets did not increase according to the country's growth, creating expanding gaps with estimated needs. The Asian Development Bank (2023) estimated that 1.6 billion USD/year is needed for the coming two decades. The MPWH implements the DKA subsidy programme to sub-national governments (valued at 9 million USD) on a small scale, which is one-hundredth the size of national projects.

Local Government Investment: The Special Capital Region of Jakarta allocated a budget for flood protection of 160 million USD in 2023, accounting for one-third of the flood protection budget in MPWH and some 3% of the total regional budget. This demonstrates the potential for subnational entities to take leadership roles. The financial sources are regional funds (30%) and interest-free loans from the central government (70%), repayable over 18 years. The operation and maintenance budget reaches 37 million USD, accounting for 20% of the total flood protection budget—relatively high because the capital

region operates large-scale facilities of diversion channels and pumping stations constructed by the central government. The regional government allocates operation and maintenance funds to the five districts. The districts then hire community members to operate and maintain pumping stations, gates, and cleaning facilities. These employees are known as the 'blue troops' and the 'green troops'.

Bandung City, the 4th largest city with 2.5 million population, allocated 8 million USD, 1.5% of the total city budget, while West Java Province allocated 1.2 million USD. The city identified 12 flood-prone locations and formulated a mitigation plan, currently operating 10 retention ponds with depths of 1.5-4 meters. The City government enforces infiltration wells as approval conditions for construction and provides financial support for their installation.

4.2 Philippines

The Philippines, consisting of over 7,000 islands with a population exceeding 100 million, is particularly vulnerable to natural disasters, especially typhoons and consequent flooding. A significant portion of the population lives in coastal areas, creating substantial challenges for protection.

Damage: From 2006 to 2023, the country suffered flood damages amounting to USD 12 billion in 2015 prices, averaging about USD 670 million per year (0.3% of GDP). Typhoons Ondoy and Pepeng caused severe floods and landslides in Metro Manila and Luzon Island in September and October 2009, with total economic damage estimated at 1.1 billion USD (0.5% of GDP). Typhoon Yolanda caused a high tide disaster in Leyte Island in 2013, with economic damage estimated at 2.3 billion USD (0.8% of GDP) (Figure 2). In 2020 and 2021, typhoons also caused damage of approximately 1 billion USD (Figure 3).

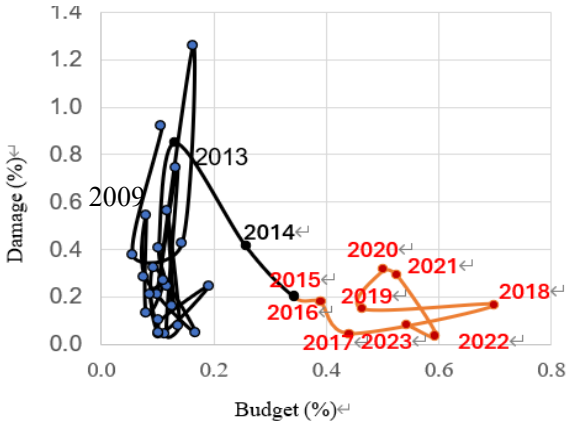

Figure 2 Flood protection budget and flood damage in the Philippines (Ratio to GDP)

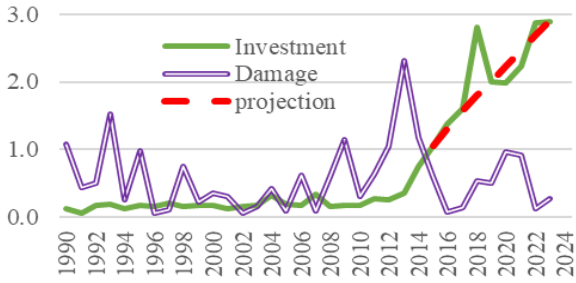

Figure 3 Flood protection budget and flood damage in Philippines (Billion USD)

Investment: The Philippines started to increase flood protection budgets following the 2013 Typhoon Yolanda disaster. The budget in 2023 became more than 8 times that of 2013 (Figure 3). Moreover, the country increased the budget in excess of the country's growth—fluctuating at less than 0.2% of GDP until 2013, then increasing to over 0.5% in the 2020s, reaching 0.7% in 2018 (Figure 2). GDP per capita reached USD 2,000 in the late 2000s, providing room to increase budgets for flood protection. This trend aligns with predictions by Ishiwatari and Sasaki (2020), validating their investment model (Figure 3).

The Department of Public Works and Highway (DPWH) implements most flood protection projects, prioritizing 18 major river basins and implementing projects in 12 river basins. The Metro Manila Development Agency, the national agency administrating Metro Manila Region, is responsible for managing flood protection facilities such as weirs, gates, and pumping stations. In addition, the government allocates the National disaster risk reduction and management fund to mainly response and rehabilitation work following disasters, with budgets of 680 million USD in 2024.

4.3 Japan

Japan, with most of its population concentrated in flood-prone coastal areas and river basins, has developed flood risk management systems over centuries.

Damage: Japan succeeded in decreasing flood damage to less than 0.5% of GDP from 1962 and further decreased damage to less than 0.2% from 1984 except 2004. However, damage recorded 0.25% (12 billion USD) in 2018 and 0.39% (18 billion USD) in 2019 (Figure 4), the figure in 2019 as a record high.

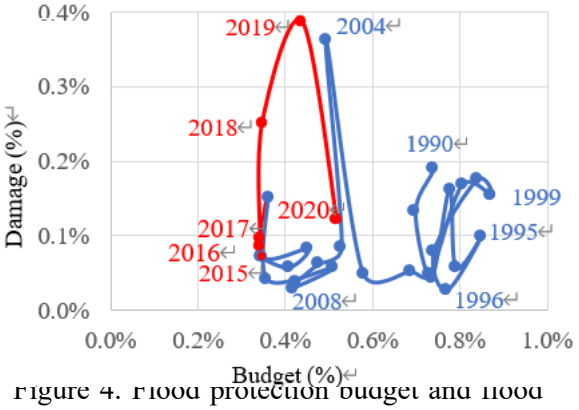

Figure 4. Flood protection budget and flood damage in Japan (Ratio to GDP)

Investment: Japan invested more than 0.9% of GDP in flood protection in the late 1970s and early 1980s, but this fell to less than 0.4% in the early 2010s (Figure 4). The country had halved investment in flood protection from 2000 to the 2010s due to a stagnant economy and tight fiscal situation. Following a series of severe flood disasters, Japan began to increase investment from 2019, reaching over 0.50% of GDP in 2020.

Japan enacted the River Law in 1896, and the national government began national flood protection projects on major rivers. Local governments contributed one-third of these national projects—a ratio maintained to the present day (Ishiwatari and Aldrich 2024). Japan started a subsidy program for medium and small rivers in 1932, where the national government subsidizes 50% of local government programs.

Local communities have been historically engaged in financial mobilization for structure measures as well as operation and maintenance work in their communities. Before the subsidy program, local communities shared some costs of local projects. For example, communities covered 30% in Saitama Prefecture and 50% in Niigata Prefecture. Even today, this community participation remains an essential component of flood management system, such as operating gates and cleaning rivers. This has fostered local ownership and rapid response capabilities during flood events.

5 Discussion

5.1 Investment Trends Analysis

The analysis reveals divergent trends in flood protection investment across the three countries. The Philippines is increasing flood protection budgets following major typhoon disasters in the 2010s. Japan's investment pattern shows a recent increase after a period of decline, reflecting renewed focus on flood protection in response to severe events.

Indonesia has not constantly increased the budget against predictions. Indonesia's failure to consistently increase its budget highlights the challenges of maintaining flood protection as a priority in the face of competing national interests. The overall budget for water resources has remained largely unchanged, with priority given to dam construction and water resource development in the new capital.

While the national government in Indonesia has not increased flood protection budgets, the Special Capital Region of Jakarta invested with a scale of one-third of the national budget. This demonstrates the potential for subnational entities to take leadership roles in addressing localized flood risks. The Jakarta region can afford to cover the cost because of its strong economic and budgetary situation.

5.2 Financing Mechanisms Comparison

The financing mechanisms employed by each country offer insights into potential strategies for sustainable flood protection investment (Table 2). Indonesia and the Philippines rely primarily on national

government funding, while Japan's model of cost-sharing among national, prefectural, and municipal governments presents an alternative approach.

In Indonesia, state-owned enterprises (PJT: Perum Jasa Tirta) conduct operation and maintenance of facilities in some river basins. PJT I manages facilities in Brantas River and expanded functions to Bengawan Solo and other river basins. PJT II manages the Jatiluhur dam and Citarum River Basin. These enterprises collect water tariffs from water supply utilities and the private sector for operation and maintenance.

In the Philippines, DPWH implements most flood protection projects, usually covering all costs without contribution from local governments. DPWH prioritized 18 major river basins and is implementing projects in 12 river basins. While the 1976 Water Act provides for local governments to take over facilities built by DPWH, in reality DPWH continues to operate and maintain the facilities following construction.

Table 2 Comparison of financial mechanisms

	Central	Local government	Community
Indonesia National project	✓		
Subsidy/ DKA	✓		
PJT		✓ Water tariff	✓
Local govt. project		✓	✓ Troops (JKT)
Philippines National project	✓		
Local govt. project		✓	
Japan National project	✓	✓ (33%)	✓
Local (Subsidy)	✓(50%)	✓(50%)	✓
Local govt. project		✓	✓

5.3 Historical and Cultural Context

The millennia-long history of cost-sharing for flood protection in Japan highlights the importance of cultural and historical factors in shaping effective flood management strategies. Japan has a history of sharing costs among national government, local government, communities, and the private sector for over a thousand years.

In Indonesia and the Philippines, the current centralized approach can be explained by the loss of traditional community-based water management practices during the colonial period and the centralized development approach after independence (Henley 2008; Tamaki 2002). As archipelagic nations, these countries have traditionally employed region-specific management mechanisms. Building on this historical foundation, traditional water management practices should be revitalized and integrated into modern contexts.

5.4 Policy Recommendations

Based on the analysis, the following policy recommendations are proposed for enhanced flood protection investment:

Cost-Sharing with Local Government: Implementing a robust cost-sharing mechanism between national and local governments can boost investment. For Indonesia and the Philippines, extending the cost-sharing model implemented in Jakarta to other provinces is recommended. Local governments should contribute to operation and maintenance costs of national projects. A tiered system should consider differences in financial capacity of local governments.

Financial Incentives for Local Governments: Establishing a system of subsidies and grants for local governments can initiate flood protection projects at the local level as Japanese case shows. A matching fund system where national contributions are tied to local investments would encourage greater commitment.

Expansion of Water Agency Financing: Expanding the role and financing capabilities of water agencies like PJT in Indonesia is recommended. Mechanisms should be developed for these agencies to reinvest a portion of their water user fees into flood protection infrastructure. This could include broadening their mandate to manage flood protection facilities and allowing them to contribute financially to construction projects.

Community Engagement and Contribution: It is essential to develop programmes that facilitate community contributions, whether in the form of cash or in-kind donations. The historical involvement of communities in Japan, and the success of the 'blue troops' and 'green troops' in Jakarta, demonstrate the potential of this approach. A framework should be created to recognise and integrate in-kind community contributions, such as labour and local knowledge, into flood protection projects. Traditional water management practices should be revitalised and integrated into modern contexts.

Long-term Financial Planning: Developing comprehensive, long-term financial plans incorporating climate change scenarios is crucial. Flood protection financing should be integrated into national development plans and climate change adaptation strategies. Regular national assessments of long-term flood protection needs should be conducted.

6 CONCLUSION

This comparative analysis of flood protection investments and financing mechanisms in Indonesia, the Philippines, and Japan has revealed the complex relationships between economic development, historical practices, governance structures, and effective flood protection. While each nation grapples with its unique set of challenges, several overarching conclusions emerge from this study.

A key finding is the critical importance of engaging multiple stakeholders—national governments, local governments, and communities—in both financing and management of flood protection initiatives. From national governments to local governments and communities, the involvement of diverse actors can lead to more comprehensive and sustainable approaches. This multi-stakeholder engagement not only enhances the financial base for flood protection but also fosters a sense of shared responsibility and ownership, which is crucial for long-term success.

The study validates the investment prediction model for the Philippines while highlighting Indonesia's challenge in maintaining flood protection as a national priority. The Philippines' trajectory demonstrates that economic growth can enable increased flood protection investment when coupled with appropriate policy responses to major disaster events. Conversely, Indonesia's experience shows that economic growth alone does not guarantee increased investment without deliberate policy prioritization.

Japan's long history of cost-sharing provides valuable lessons for developing countries, though its approach reflects unique cultural and historical factors that have evolved over more than a millennium. The influence of colonial history on current centralized approaches in Indonesia and the Philippines underscores the need for strategies that are not only technologically sound but also culturally appropriate and aligned with local traditions and practices.The study also underscores the significant influence of historical and cultural contexts on current flood protection strategies. Each country's approach is deeply rooted in its unique water management practices, which have evolved over time. Traditional water management practices should be revitalized and integrated into modern contexts.

This study has several limitations. The lack of standardized budget definitions across countries makes direct comparison challenging, as Indonesian and Philippine data primarily reflect national spending while Japanese data include local government budgets. Additionally, the analysis relies on budget allocations rather than actual expenditures. Despite these limitations, the comparative framework provides a useful foundation for understanding financing mechanisms and flood protection outcome.

Future research should explore quantitative analysis of long-term benefits of different financing approaches, including poverty alleviation and inequality reduction effects. Such research could analyse the socioeconomic impacts of flood protection investments and provide valuable data to support policy decisions and investment strategies. Additionally, studies should examine how emerging technologies such as green infrastructure and advanced risk assessment can be appropriately integrated into planning and investment frameworks.

This analysis underscores the complex and dynamic nature of flood protection in an era of climate change and societal transformation. It highlights the need for adaptive, multi-faceted approaches that combine robust financing mechanisms, stakeholder engagement, and flexible policy frameworks. As countries around the world grapple with increasing flood risks under climate change, the lessons drawn from Indonesia, Japan, and the Philippines offer valuable insights for developing resilient and sustainable flood protection strategies.

7 ACKNOWLEDGEMENTS

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