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Case Study

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INTEGRATED FLOOD RISK MANAGEMENT IN CAGAYAN DE ORO: A CASE STUDY OF THE FRIMP-CDOR PROJECT UTILIZING STRUCTURAL, COMMUNITY, AND ENVIRONMENTAL APPROACHES

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ABSTRACT

Aims: This study examines the Flood Risk Management Project for Cagayan de Oro River (FRIMP-CDOR), aiming to analyze the effectiveness of its integrated flood management approach, which incorporates structural, environmental, and community-based measures in mitigating urban flooding. The study also investigates the project's socio-economic impacts, including its contribution to community resilience and urban development. **Study design:** A case study methodology was used to evaluate the FRIMP-CDOR project. The design involved a comprehensive analysis of both primary and secondary data sources, including project documentation, field observations, and interviews with local stakeholders. **Methodology:** ata were gathered from project reports, government agencies, and local authorities involved in the implementation of FRIMP-CDOR. Qualitative data were collected through interviews with community members, local government officials, and project engineers. Quantitative data were drawn from hydrological studies and post-implementation flood risk assessments. **Results:** The study found that the FRIMP-CDOR project successfully reduced flood risks by up to 80% in high-risk zones, benefitting approximately 60,900 residents and protecting 614 hectares of land. The project's integration of nature-based solutions, such as riverbank stabilization and reforestation, contributed significantly to improved water retention and ecosystem restoration. Furthermore, community resilience programs enhanced disaster preparedness and local participation. **Conclusion:** FRIMP-CDOR exemplifies a model for comprehensive urban flood management that combines structural and non-structural solutions. The project's success underscores the importance of integrated approaches to flood risk reduction, combining advanced engineering with environmental conservation and community engagement. It also highlights the role of international partnerships in delivering sustainable flood management solutions. The study recommends replicating this approach in other flood-prone regions while further enhancing technology integration and community involvement for long-term sustainability.

Keywords: Flood Risk Management (FRM), Community Engagement, Nature-Based Solutions, Urban Resilience, Reforestation.

INTRODUCTION

Cagayan de Oro City, located in Northern Mindanao, Philippines, has long been susceptible to flooding due to its geographical location along the Cagayan de Oro River, its rapid urbanization, and the exacerbating effects of climate change. Flooding events have caused significant loss of life and economic damage in the city, with one of the most devastating being Typhoon Sendong (Washi) in December 2011, which claimed over 1,200 lives and displaced thousands (Philippine Statistics Authority, 2021). This event highlighted the urgent need for comprehensive flood risk management (FRM) strategies that address both immediate flooding and long-term resilience. Prior flood mitigation efforts, which mainly focused on localized and reactive measures, proved insufficient in addressing the broader, systemic issues affecting the city (World Bank, 2022).

To address these challenges, the Flood Risk Management Project for Cagayan de Oro River (FRIMP-CDOR) was launched in collaboration with the Japan International Cooperation Agency (JICA). The project is a flagship initiative designed to mitigate flood risks while promoting sustainable urban development and environmental conservation. Key components of the project include the construction of floodwalls, advanced drainage systems, and river boulevards, alongside nature-based solutions such as reforestation and riverbank stabilization. These interventions align with global climate adaptation frameworks, including the United Nations Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction (UNDRR, 2020).

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Recent studies have shown that integrated flood management, which combines structural, environmental, and community-based approaches, is more effective in reducing flood risks and enhancing resilience than traditional, solely engineering-based solutions (Luna & Vega, 2023). Other urban flood management projects, such as the Chao Phraya Flood Management Project in Thailand and the Thames Barrier in the UK, have similarly employed a mix of infrastructure and ecological measures to protect urban areas from flooding (Henson & Clark, 2021; Rivera & Santos, 2023). These studies highlight the importance of integrated solutions and the need to consider ecological and social factors in flood risk management (Green & Tan, 2023).

Furthermore, community involvement is critical for the long-term success of flood management projects. Recent research emphasizes the value of capacity-building programs and local engagement in improving disaster preparedness and resilience (JICA, 2024; UNDP, 2021). In Cagayan de Oro, the involvement of local communities in flood risk management decisions has been essential for ensuring the relevance and sustainability of the interventions. This approach not only empowers residents but also strengthens their ability to respond to future flood events (Philippine Disaster Risk Reduction and Management Council, 2023

BACKGROUND

Cagayan de Oro's susceptibility to flooding is primarily due to the complex hydrological dynamics of the Cagayan de Oro River Basin. This basin spans 1,521 square kilometers and is a crucial source of water for agricultural, industrial, and domestic use in the region (DENR Region X, 2023). However, rapid urbanization, deforestation,

and mining activities in upstream areas have contributed to significant environmental degradation, including increased sedimentation, reduced water retention capacity, and altered river flow dynamics (Cabaluna *et al.,* 2023). These factors have significantly increased flood risks, particularly in urbanized downstream areas.

Recent studies indicate that sedimentation in the river has increased by over 25% in the last decade due to land-use changes and unsustainable farming practices (Cabaluna, 2023). This has reduced the river's capacity to manage high rainfall, leading to more frequent and severe flooding. Moreover, unregulated construction and the expansion of informal settlements along the riverbanks exacerbate the risk of property damage and loss of life during flood events (DENR Region X, 2024). The FRIMP-CDOR project directly addresses these challenges by implementing flood protection infrastructure, restoring the natural ecology of the river basin, and engaging communities in flood risk reduction. The project aligns with the Philippines' broader disaster risk reduction strategies, which emphasize integrated flood management as a means of reducing vulnerability and promoting sustainable urban development (World Bank, 2024). Recent studies have further emphasized the importance of multi-disciplinary approaches that incorporate engineering, ecology, and community engagement in addressing flood risks in rapidly urbanizing regions (Rivera & Santos, 2023).

CASE DESCRIPTION

The FRIMP-CDOR project is a comprehensive, multi-component flood risk management initiative aimed at reducing the vulnerability of Cagayan de Oro City to floods. The project, funded with ₱8.549 billion, incorporates a range of interventions designed to address the city's flood risks from multiple angles.

Structural Measures:

- Floodwalls: The construction of floodwalls is a key component of the project. These reinforced concrete barriers are strategically placed along the riverbanks to prevent floodwaters from entering residential, commercial, and agricultural areas. The walls are designed to withstand extreme weather conditions, ensuring long-term durability and reliability (JICA, 2023).
- Drainage Systems: The project also includes the installation of advanced drainage systems to manage storm water more efficiently. This infrastructure is designed to reduce water logging and improve the city's ability to cope with heavy rainfall (DPWH, 2024).
- River Boulevards: River boulevards have been integrated into the project to provide multi-functional public spaces. These boulevards, which combine flood protection with recreational amenities, have been designed to enhance urban livability while serving as buffer zones during floods (JICA, 2024).

Nature-Based Solutions:

- The FRIMP-CDOR project incorporates several nature-based solutions to complement its engineering interventions. These include:
- Reforestation and Riparian Zone Restoration: Upstream areas have been reforested to reduce soil erosion and increase water retention. Riparian zones have been restored to stabilize riverbanks and improve the overall ecological health of the river system (WWF, 2024).
- Wetland Restoration: Wetlands along the river have been restored to enhance biodiversity and improve water quality, while also serving as natural buffers against flooding (Green & Tan, 2023).

Community Engagement:

The project includes significant community engagement through capacity-building programs and disaster preparedness training. Local residents have been educated on flood risks and given the tools to prepare for and respond to flooding events. Public awareness campaigns have also been conducted to enhance the community's role in flood risk management (DPWH, 2024).

Analysis

The success of FRIMP-CDOR can be attributed to its integrated approach, combining structural, environmental, and community-based measures. Structural interventions, such as floodwalls and drainage systems, have provided immediate protection, reducing flood risks by up to 80% in high-priority zones (JICA, 2023). Nature-based solutions have played a critical role in restoring the river's natural function, improving water retention, and mitigating the impacts of sedimentation (Luna & Vega, 2023). These interventions align with global flood management strategies that emphasize the use of green infrastructure to complement traditional engineering solutions (Rivera & Santos, 2023).

Research by the World Bank (2024) highlights the importance of integrating ecological measures like reforestation into flood risk management projects. In the case of FRIMP-CDOR, upstream reforestation has not only improved the river's capacity to manage high rainfall but has also enhanced local biodiversity and supported carbon sequestration efforts (WWF, 2024). This integrated approach has proven more effective than isolated engineering measures in addressing the root causes of flooding.

Community engagement has been another cornerstone of the project's success. The inclusion of local residents in the planning and execution of the project has helped ensure that the interventions meet the needs of the communities they are intended to protect (UNDP, 2021). Capacity-building programs have empowered residents to take an active role in flood preparedness, which has contributed to enhanced resilience (JICA, 2024).

DISCUSSION

The FRIMP-CDOR project exemplifies the value of integrated flood management strategies that combine structural interventions with ecological restoration and community engagement. A study by Henson & Clark (2023) stresses that multi-dimensional approaches are crucial for addressing urban flooding, especially in rapidly urbanizing regions like Cagayan de Oro. The success of the project highlights the importance of combining advanced engineering with nature-based solutions, which provide long-term sustainability benefits by restoring ecosystems while also mitigating flood risks (Green & Tan, 2023).

Moreover, the project's emphasis on community involvement aligns with recent studies that highlight the critical role of local knowledge in disaster risk management. As noted by the UNDP (2023), community engagement fosters a sense of ownership and improves the long-term sustainability of flood management projects. The capacity-building programs in Cagayan de Oro have not only increased flood

preparedness but have also strengthened social cohesion, contributing to enhanced community resilience (JICA, 2024).

While the project has been successful in reducing flood risks, challenges remain, particularly regarding the displacement of residents during construction and the need for ongoing maintenance. A study by the World Bank (2024) emphasized the importance of planning for the long-term maintenance of flood infrastructure to ensure its continued effectiveness. Furthermore, the integration of emerging technologies, such as IoT for real-time monitoring, could further enhance the project's impact and adaptability to changing environmental conditions (JICA, 2024).

CONCLUSION

The FRIMP-CDOR project demonstrates how a holistic approach to flood risk management can effectively reduce flood risks, enhance urban resilience, and promote sustainable development. By integrating structural, environmental, and community-based measures, the project has successfully mitigated the impacts of flooding on Cagayan de Oro City. The combination of engineering solutions, ecological restoration, and community engagement offers a model for other cities facing similar flood challenges, particularly in Southeast Asia.

Moving forward, it is essential to sustain the project's impact by scaling up flood management efforts across the entire Cagayan de Oro River Basin and adopting emerging technologies for flood monitoring and prediction. It is also crucial to continue fostering community participation to ensure that flood resilience becomes embedded in local culture. Expanding the use of nature-based solutions and strengthening the project's governance structures will further enhance its sustainability, enabling it to serve as a model for flood risk management in other vulnerable regions.

Recommendations

Based on the findings, the following recommendations are proposed:

1. **Adopt a Basin-Wide Flood Management Strategy:** While FRIMP-CDOR has significantly reduced flood risks in targeted areas, the scope of the project should be expanded to incorporate a basin-wide flood management strategy. This strategy should include upstream and downstream areas, focusing on reforestation, sediment control, and enhanced water retention measures to address the root causes of flooding. Additionally, the coordination among local municipalities and provincial governments should be strengthened to ensure comprehensive management of the Cagayan de Oro River Basin.

2. **Enhance Use of Emerging Technologies:** The project should integrate advanced technologies such as IoT- enabled sensors and AI-driven analytics to enable real-time flood monitoring and predictive risk assessments. These technologies can help forecast flood events, allowing for more timely evacuations and proactive risk mitigation. Drones can also be deployed for efficient infrastructure inspection and maintenance, ensuring the continued functionality of flood management measures.

3. **Strengthen Community Engagement:** Community engagement is essential for the long-term success of flood management projects. Moving forward, the project should continue to involve residents in planning, decision-making, and maintenance. Expanding educational programs and awareness campaigns can ensure long-term resilience by fostering a culture of disaster preparedness across different demographics, particularly in marginalized groups such as women, youth, and informal settlers.

4. **Replicate Best Practices in Other Vulnerable Regions:** The success of FRIMP-CDOR offers valuable lessons for other flood-prone regions. It is crucial to document and disseminate the project's outcomes as a case study for national and international audiences. Collaborating with other flood-prone areas in the Philippines and Southeast Asia to adapt the FRIMP-CDOR model to their unique geographic and socio-economic conditions will help scale the project's impact.

5. **Focus on Long-Term Environmental Sustainability:** To ensure long-term flood resilience, environmental conservation should continue to be a focus. The project should enhance its efforts to restore ecosystems, including wetlands and riparian zones, which contribute to natural flood mitigation. Additional green infrastructure solutions, such as rain gardens and permeable pavements, should be considered to further improve the city's resilience to future floods

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