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Initiatives of Local Government Units in the Prevention, Mitigation, and Preparedness Towards the Effects of Flooding in Selected Cities and Municipalities in the Province of Bulacan

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Abstract

The study centered on the flood mitigation initiatives of selected LGUs in the Province of Bulacan, namely Calumpit, Hagonoy, Paombong, the City of Malolos, Obando, and Bulakan. Programs initiated and implemented by these Local Government Units (LGUs) in flood-prone and low-lying areas frequently affected by flooding served were systematically examined and utilized as benchmarks for the development of an enhanced Flood Management Master Plan tailored for the province's geographic and socio-environmental context. This approach reflects Safety and Risk Management Theory, emphasizing the systematic identification, assessment, and reduction of hazards, and Public Safety Theory, which underscores the protection of lives and community well-being through coordinated local governance.

The study involved eighty-seven (87) participants, consisting of six (6) Local Chief Executives from the different cities and municipalities, six (6) Planning Officers, six (6) C/MDRRMOs, nine (9) Rescue Team Leaders, and 60 community members from the selected LGUs. These respondents were purposefully selected for their direct knowledge and experience with the implementation of flood mitigation programs, ensuring that the data reflected both institutional and community perspectives. This was conducted from July 25, 2021, to October 2021. The researcher utilized a mixed-methods approach that combined quantitative surveys with qualitative interviews and thematic analysis. This methodological design enabled the study to capture both measurable program effectiveness and the nuanced experiences of stakeholders, providing a comprehensive understanding of flood risk management practices in line with both risk reduction frameworks and public safety imperatives.

Keywords: Disaster Risk Reduction and Management. Prevention. Mitigation and Preparedness

Introduction

Flood preparedness and mitigation plans protect lives and properties from the flood's potentially devastating effects. It confirmed the notion of Rojas (2014) that no nation has been spared from the shifts in extreme weather that have brought death, damage, and desolation in places affected by climate change. It signifies that disasters can strike anytime and anywhere, potentially causing irreversible damage to life and property if appropriate measures are not implemented. Such events can also bring out both the best and worst of human nature. The way actions are taken plays a crucial role in determining how people fare in the aftermath of these experiences. In response, individuals and societies alike have many attempts to decrease their exposure to the consequences of these disasters, developing measures to address the initial impact; regardless of the approach adopted, all these efforts have the same goal (Coppola, 2011). In this age, there is a need for a particularly vulnerable country like Philippines to be more aware and steadfast in our efforts in learning to live with the unstoppable forces of nature over time and people must do so in a very scientific and practical manner (Panadero, 2014). A flood can occur in every single nation in the world. The Organization for Economic Development (2019) reports that it causes more than \$40 billion in damage worldwide annually. People who live in low-lying areas near water or behind a river or a dam are at even greater risk of the danger caused by flooding. During a flood, people try to move themselves and their most precious belongings to higher ground quickly. Flooding is also a severe concern in the Philippines; our country lies in the path of turbulent typhoons, with about 20 crossing the Philippine area of responsibility each year. An average of 9 made landfall. The archipelagic nature of the Philippine coastal areas increases susceptibility to storm surges, tsunamis, and sea-level changes. Floods are common due to rains brought by typhoons and the monsoon.

Aside from Metro Manila, Central Luzon, mainly the province of Bulacan, was also regularly flooded because of frequent typhoons, particularly all of the low-lying areas of its cities and municipalities. Bulacan has been increasingly affected by natural hazards. Typhoons and floods, drought, and storms often trigger secondary hazards such as landslides, fires, infestations, and outbreaks of animal diseases. The province has a topography described by the flat western side and islands on the eastern side. The upland on the eastern side gradually increases in altitude while nearing the Sierra Madre base, a significant mountain range in the Philippines found in the Cordillera. Regarding its physical features, the province is divided into three areas known as the coastal areas of Bulacan, Hagonoy, the City of Malolos, Paombong, Obando, and the lowland or central areas of Calumpit (DVRA, 2017).

A high risk of flooding would probably occur in areas mainly along with the coastal municipalities of Hagonoy, Paombong, Obando, Bulacan, and the City of Malolos, and the nearby municipalities of Calumpit, Pulilan, Balagtas, and the City of Meycauayan, as reported by the Provincial Disaster Management Office (PDMO). There is a total area of 96,768.84 hectares where a high risk of flooding has occurred. Persistent two to three days back flooding was also noted within a total land area of 2,076 hectares found along the western boundaries of Hagonoy and Calumpit. On the other hand, population and settlement exposure to flooding indicates the extent to which the people and their settlements are at risk or are most likely to be affected by the flood. In the province of Bulacan, the municipality of Obando appears to have the highest population exposure at 100 percent of the population. Aside from population settlements, agriculture and built-up areas were also affected. Among the highly exposed agricultural areas are Obando, Bocaue, Hagonoy, Paombong, and Bulacan. Almost all (above 90%) of the agricultural areas in these municipalities are exposed to flooding hazards. Meanwhile, flooding alone is not the only hazard experienced by the Province of Bulacan.

According to the Provincial Disaster Management Plan (2019), the risk profile of Bulacan is summarized by its geographical location. Bulacan is prone to both natural and artificial catastrophes as it experiences

an average of two cyclones every year and other accidents caused by human activities. Flooding is also expected twice every year. Though the three dams, namely Angat, Ipo, and Bustos, serve as flood mitigating structures, flooding still occurs, especially during stormy seasons when excess water from the hinterlands and rivers in the north runs down to some areas of the province.

Flood is the most common hazard in Bulacan province, specifically in the low-lying areas and coastal towns. Heavy rains from typhoons or monsoon rains usually cause it. The coastal barangays from Obando, Bulakan, Hagonoy, Paombong, and the City of Malolos also experience floods caused by high tides from Manila Bay. Moreover, Calumpit, Hagonoy, and Paombong tried to improve drainage systems and implement flood mitigation initiatives such as enhancing floodways and floodwalls, dredging rivers, and flood forecasting.

However, there is no significant change observed as the streets of Calumpit, Hagonoy, and Paombong quickly submerge in water when there is medium and heavy rainfall, proving only the vulnerability of the municipality up to this point. These annual scenarios of flooding that have contributed to a loss of life and millions of pesos worth of damage to properties and crops in low-lying areas, cities, and municipalities have inspired the researcher as a resident of the City of Malolos.

This has prompted the researcher to conduct a study to find out the mitigation strategies used by the selected LGUs and the contribution of different government agencies members of the Local Disaster Risk Reduction Management Council (LDRRMC) in adopting and implementing the mitigation plans based on Republic Act 10121, otherwise known as the Philippine Disaster Risk Reduction and Management Act. This is in preparation for an enhancement of the flood mitigation master plan that may be useful in the low-lying areas in Bulacan and different lowland areas in the Philippines if applied.

Statement of the Problem

The general problem of the study is: How may the prevention, preparedness, and mitigation initiatives and strategies of selected LGUs in Bulacan towards flood control be evaluated for the enhancement of their flood mitigation master plan?

This study sought answers to the following questions:

1. How may the current flooding occurrences and conditions in different LGUs in Bulacan be described?
2. How may the extent of implementation of LGU-initiated programs minimize the effects of flooding in terms of:
 - 2.1 prevention and mitigation;
 - 2.2 preparedness;
 - 2.3 rescue and relief operations;
 - 2.4 rehabilitation and recovery programs; and
 - 2.5 sustainability?
3. How did the LGU-initiated programs towards flood mitigation address the following based on the perception of the local community:
 - 3.1 life of people;
 - 3.2 properties;
 - 3.3 public utilities; and

3.4 economic condition?

4. What problems have been encountered by the LGU communities in implementing the flood mitigation program?
5. What enhancement program may be incorporated in the proposed flood mitigation master plan to guide the different LGUs in Bulacan Province to mitigate and control the flooding incidents?

Assumption of the Study

Different LGUs in the Province of Bulacan continue to experience recurrent flooding, resulting in significant social, economic, and environmental impacts on affected communities. The current flood mitigation programs implemented by the six selected LGUs, while addressing certain risks, require further enhancement to achieve their intended objectives fully. Adopting and implementing an enhanced flood mitigation program that systematically incorporates the challenges and experiences of various stakeholders can strengthen local governance and disaster preparedness. Such a program would enable LGU and barangay officials to implement targeted interventions, improve coordination, and enhance community awareness, ultimately reducing the vulnerability of local populations and increasing resilience to future flooding events. By integrating evidence-based planning, community participation, and proactive risk management, the enhanced program ensures that mitigation efforts are not only responsive to current hazards but also sustainable and adaptable to evolving flood risks.

Review of Related Literature and Study

Prevention, Preparedness, and Mitigation Initiatives and Strategies Towards Flood Control

Flooding remains one of the most frequent and destructive natural hazards, posing serious threats to lives, livelihoods, infrastructure, and sustainable development. As climate change intensifies weather patterns and rapid urbanization alters natural drainage systems, the need for effective prevention, preparedness, and mitigation initiatives has become increasingly critical. This study examines the strategies and initiatives employed by different Local Government Units in the Province of Bulacan toward flood control and mitigation, emphasizing proactive and integrated approaches to disaster risk reduction.

The researcher provided an in-depth discussion of the different policies, support mechanisms, and assistance initiatives undertaken by the government to mitigate flood risks and enhance flood control measures.

The flood mitigation initiatives and strategies in the Province of Bulacan are anchored on the national development vision articulated in NEDA's Ambition 2040: "Ensure Safety and Build Resilience." This long-term vision underscores the aspiration of providing a comfortable, secure, and resilient life for every Filipino by recognizing that vulnerability reduction is integral to sustainable development. It acknowledges disaster and climate risks such as flooding as factors that erode development gains and constrain growth potential. In this context, the incorporation of Disaster Risk Reduction and Management (DRRM) strategies into sectoral plans and local programs is essential to ensuring community safety and resilience during hazardous events.

Aligned with this national vision, the study highlights the flooding in Bulacan as not merely a recurring natural hazard but a developmental challenge that requires proactive, adaptive, and integrated responses. As Edwards (2005) emphasized, while climate change impacts cannot be stopped entirely, communities must adapt to changing realities by strengthening resilience. This perspective reinforces the role of the government in capacitating LGUs, in partnership with stakeholders, to institutionalize mechanisms that reduce disaster risks, address projected climate threats, and enhance preparedness and response capacities at all levels.

Within this framework, the researcher discusses the current flooding occurrences and conditions in selected LGUs in Bulacan, namely Calumpit, Hagonoy, Paombong, Bulakan, Obando, and the City of Malolos, which are frequently affected by flooding due to heavy rainfall, typhoons, monsoon rains, and high tide conditions. These flooding events have repeatedly necessitated declarations of a state of calamity, highlighting the vulnerability of these communities and the urgency of strengthening flood control and mitigation strategies.

The extent of implementation of LGU-initiated flood mitigation programs was also examined across the four thematic areas of DRRM. These are the prevention and mitigation, preparedness, response, rehabilitation, and recovery, as well as their sustainability. Prevention and mitigation initiatives include infrastructure development, drainage improvement, river management, and land-use planning. Preparedness efforts involve early warning systems, contingency planning, community drills, and capacity-building activities. Rescue and relief operations focus on evacuation procedures, emergency assistance, and protection of vulnerable groups, while rehabilitation and recovery programs aim to restore damaged infrastructure, livelihoods, and essential services. The sustainability of these initiatives is assessed in terms of institutional support, funding mechanisms, and integration into long-term local development plans.

Special emphasis is given to inclusive and sector-sensitive policies, particularly the implementation of Republic Act No. 10821, or the Children Emergency Relief and Protection Act. This law mandates the protection of children before, during, and after disasters and establishes a comprehensive national strategy for child-centered disaster response. In flood-prone LGUs in Bulacan, RA 10821 provides a policy basis for ensuring child protection through emergency programs, prevention of exploitation and trafficking, continuity of education, child participation in DRR planning, and child-centered training of responders. These provisions reinforce the need for flood mitigation programs to address the differentiated impacts of disasters on vulnerable populations. Moreover, the discussion incorporates the perceptions of the local community regarding how LGU-initiated flood mitigation programs address critical concerns, including the protection of human life, safeguarding of properties, continuity of public utilities, and the overall economic condition of affected areas. Community perspectives are essential in evaluating program effectiveness, as resilience is shaped by local knowledge, social capital, and community networks.

The researcher also aimed to explore challenges encountered by LGUs and communities in implementing flood mitigation programs, such as limited financial and technical resources, coordination issues, infrastructure constraints, and varying levels of community participation. These challenges point to gaps between policy frameworks and actual implementation on the ground.

The Joint Memorandum Circular (JMC) No. 2013-1 serves as a pivotal policy instrument that operationalizes the intent of Republic Act No. 10121 by providing clear guidelines to Local Government Units (LGUs) on the allocation and utilization of the Local Disaster Risk Reduction and Management Fund (LDRRMF). Its emphasis on transparency and accountability directly influences the effectiveness of flood control initiatives, as proper fund management ensures that resources are directed toward priority disaster risk reduction activities rather than reactive or ad hoc responses.

Anchored on the National Disaster Risk Reduction and Management Plan (NDRRMP) 2011–2028, the JMC requires LGUs to prepare Local DRRM Plans (LDRRMPs) that are responsive to local hazards, including flooding. This policy linkage highlights the importance of aligning national strategies with local realities, particularly in flood-prone areas. By mandating LGUs to contextualize prevention and mitigation, preparedness, response, and recovery strategies, the policy strengthens localized flood control planning and implementation.

In terms of flood prevention and mitigation, the policy framework enables LGUs to prioritize investments in structural and non-structural measures such as drainage improvement, flood control infrastructure, river management, hazard mapping, and land-use regulation. The availability of LDRRMF, as guided by the JMC, supports proactive measures aimed at reducing exposure and vulnerability before flood events occur. This demonstrates a shift from reactive disaster response to risk-informed development planning.

With regard to preparedness, RA 10121 and the NDRRMP emphasize capacity-building and institutional readiness. The policy framework supports the allocation of funds for early warning systems, contingency planning, evacuation drills, emergency communication systems, and community-based disaster preparedness programs. These initiatives are essential in minimizing loss of life and ensuring timely and coordinated actions during flooding incidents. The requirement for LGUs to institutionalize preparedness mechanisms enhances their ability to respond effectively to recurring flood hazards.

Although mitigation and preparedness are prioritized, the inclusion of all four thematic areas under Section 12 (6) of RA 10121 ensures a holistic flood control approach. The integration of response and rehabilitation reinforces continuity in disaster management, allowing LGUs to transition from immediate flood response to long-term recovery and resilience building. This comprehensive framework supports sustainable flood control by addressing both immediate impacts and underlying risk factors.

Overall, the policy framework established by JMC No. 2013-1, RA 10121, and the NDRRMP strengthens flood control efforts by institutionalizing prevention, preparedness, and mitigation as core responsibilities of LGUs. However, the effectiveness of these policies ultimately depends on the extent of implementation, technical capacity, and commitment of LGUs to prioritize proactive flood risk reduction over short-term response measures. These findings underscore the need for strengthened monitoring, capacity enhancement, and strategic planning to maximize the impact of flood control initiatives at the local level.

Disaster mitigation efforts have significant and measurable effects on local communities, particularly when resilience is assessed at the community level. As emphasized by Frazier et al. (2013), communities possess an inherent understanding of their vulnerabilities, risk exposure, and adaptive capacities, which positions them as critical actors in flood control and disaster risk reduction. This localized knowledge

enables communities to identify flood-prone areas, anticipate hazard patterns, and develop context-specific strategies to resist, absorb, and recover from flooding events.

From the perspective of flood prevention and mitigation, strong social norms, social capital, and social networks contribute to collective action, such as maintaining drainage systems, enforcing land-use regulations, and supporting environmental protection initiatives. These community-driven actions complement structural flood control measures implemented by LGUs and enhance the effectiveness of mitigation strategies by addressing behavioral and social dimensions of flood risk.

In relation to preparedness, the literature highlights that preparedness plans developed internally by communities are often more effective than externally designed interventions. Community-based preparedness planning ensures that evacuation routes, early warning systems, and emergency protocols are grounded in local realities. During flood events, neighbors and local peers typically act as the first responders, underscoring the importance of community readiness in reducing casualties and facilitating timely response. This finding supports the integration of community participation into LGU-led flood preparedness programs.

The role of government, as discussed by Alcayana et al. (2016), further strengthens disaster preparedness and mitigation through institutional support. By providing checklists, communication systems, contingency templates, and resource inventories, government agencies enhance the technical and operational capacity of LGUs and communities. These tools support systematic planning and coordination, ensuring that flood control measures are not only reactive but also anticipatory and organized

Capacity building emerges as a critical outcome of disaster risk reduction initiatives. Fernandez (2015) demonstrated that community-driven DRR initiatives in Iloilo City were successful when supported by strong social networks, access to alternative financing, technical expertise, and community-managed information systems. These elements are particularly relevant to flood mitigation, as they enable communities to sustain preparedness activities, maintain flood control infrastructure, and recover more effectively after flood events.

Furthermore, the involvement of schools and student groups presents an opportunity to strengthen flood preparedness and mitigation. Educational institutions can serve as centers for awareness, training, and information dissemination, fostering a culture of disaster preparedness among youth and communities. This untapped potential supports long-term resilience by embedding disaster risk reduction principles into community life.

Therefore, the effects of disaster mitigation on local communities demonstrate that effective flood control extends beyond physical infrastructure and relies heavily on social cohesion, local capacity, and participatory governance. Integrating community-based approaches with LGU-led prevention, preparedness, and mitigation strategies enhances resilience, reduces flood impacts, and promotes sustainable disaster risk management.

The Local Disaster Risk Reduction and Management Fund (LDRRMF) serves as a vital financial mechanism for local governments to address the impacts of disasters and enhance community resilience. Its utilization is guided by the Joint Memorandum Circular No. 2013-1 issued on March 25, 2013, and by Republic Act 10121, which is the Philippine Disaster Risk Reduction and Management Act of 2010. These

policies outline that the fund should be used to support activities across all phases of disaster management, including prevention and mitigation, preparedness, response, rehabilitation, and recovery.

Under the law, thirty percent of the LDRRMF is set aside as a Quick Response Fund (QRF) to provide immediate relief and recovery to affected communities. The remaining seventy percent is allocated to thematic disaster management programs, which cover planned interventions for prevention, preparedness, rehabilitation, and recovery. In situations where the allocated funds are insufficient, the Provincial Disaster Risk Reduction and Management Council (PDRRMC) may recommend a realignment of the funds or request approval from the Sangguniang Panlalawigan to utilize additional resources, ensuring that the needs of affected communities are met promptly. Any unexpected LDRRMF funds accrue to a special trust fund for five years and, if still unutilized after this period, revert to the general fund for social services.

In the Province of Bulacan, floods and typhoons are the most common disasters, particularly during the rainy season and monsoon rains. The municipalities of Calumpit, Hagonoy, Paombong, Bulakan, Obando, and the City of Malolos are particularly vulnerable, making them key subjects for studies on fund utilization and disaster resilience. Historical events highlight the practical application of LDRRMF policies. On November 12, 2020, the province declared a State of Calamity following the impact of Typhoon Ulysses, which affected over 800,000 residents, prompted the evacuation of 18,671 individuals, and caused estimated damages of over 417 million pesos to homes, infrastructure, and agriculture. Similarly, in July and August 2018, successive tropical storms, including Henry, Inday, Josie, and Karding, resulted in widespread flooding, prompting the PDRRMC to recommend a State of Calamity declaration and coordinate relief and rehabilitation efforts.

The governance of LDRRMF emphasizes a systematic approach to decision-making. Local DRRM offices identify the needs of affected communities and propose interventions, which the PDRRMC then evaluates. Resolutions are passed to recommend fund utilization or realignment, which require approval from the Sangguniang Panlalawigan. This structured process ensures that funds are allocated appropriately, responsive to emergent needs, and used effectively for disaster risk reduction and management activities.

While the policies provide a strong framework for disaster preparedness and response, challenges remain. The reliance on provincial approvals may occasionally delay immediate relief, and the high vulnerability of low-lying municipalities necessitates continuous investment in preventive infrastructure. Moreover, large-scale disasters can exceed the allocated LDRRMF, requiring additional funding and coordination. Despite these challenges, the experiences of Bulacan illustrate how the LDRRMF, when properly managed, enables communities to recover and rebuild more quickly while fostering resilience against future disasters.

In conclusion, the utilization of the LDRRMF in Bulacan demonstrates a comprehensive approach to disaster management, combining legal mandates, strategic financial allocation, and local governance. Historical experiences, such as the responses to Typhoon Ulysses and repeated flooding events, underline the importance of proactive planning, flexible fund management, and adherence to established procedures to safeguard the welfare of communities.

Four Thematic Areas of Disaster. The National Disaster Risk Reduction and Management Plan (NDRRMP) fulfills the requirement of RA No. 10121, which provides the legal basis for policies, plans, and programs to deal with disasters. The NDRRMP covers four thematic areas, namely, (1) Disaster Prevention and Mitigation; (2) Disaster Preparedness; (3) Disaster Response; and (4) Disaster Rehabilitation and Recovery, which correspond to the structure of the National Disaster Risk Reduction and Management Council (NDRRMC). The Framework envisions a country of “safer, adaptive and disaster-resilient Filipino communities toward sustainable development.” It conveys a paradigm shift from reactive to proactive DRRM, wherein men and women have increased their awareness and understanding of DRRM, with the end goal of increasing people’s resilience and decreasing their vulnerabilities.

Disaster Prevention and Mitigation provides vital actions and activities around identifying and analyzing hazards, risk analyses, mainstreaming DRRM into development plans, and minimizing the impact of disasters in terms of casualties and damage. It underscores the need for sound scientific information and analysis of risk and hazards. One of the best PPAs for preparation and mitigation of the province is to develop the following mitigations for the communities, especially for the low-lying areas, namely:

Local Flood Forecasting and Early Warning Systems detect, forecast, and, when necessary, issue alerts related to upcoming hazard events. In the Province of Bulacan, they installed an early warning monitoring system for the province called the Community-Based Flood Mitigation Management Program (CBFMMP). The program's purpose is to have a non-structural, community-based holistic approach to flood disaster mitigation aspects. The program encompasses hydrological monitoring, information exchange, and warning to the community of sub-basin areas within the Pampanga River Basin, particularly river systems within the province. As of 2013, it is also proposed to implement a local early warning system in the Santa Maria River basin southeast of Bulacan through funding from the Greater Metropolitan Manila Authority READY program.

Conceived by the Pampanga River Flood Forecasting and Warning Center (PRFFWC) and solely funded by the Provincial Government of Bulacan, the CBFMMP system is composed of a network of rainfall and water level monitoring stations and flood markers located strategically within the Pampanga river basin and a communication system for data and information transfers between the monitoring stations, the municipal/city/barangay disaster action team through its trained volunteers, and the operation center (PDRRMO and PRFFWC). The CBFMMP, its use, and benefits were also communicated to LGUs and vulnerable groups, and the measures the people can take to prepare for and mitigate the adverse impact of floods in their localities.

Modernization of the Community-Based Flood Mitigation Management program. Through the initial efforts of PDRRMC, headed by the Bulacan Governor Wilhelmino Sy-Alvarado, the Modernization of Community-based Flood Mitigation Program (CBFMMP) was realized.

At the Operation Center (OpCen) is the Communication, Control, and Command Center (C4), which was completed with a variety of state-of-the-art equipment and systems that will aid in monitoring a massive geography. It is known that closed-circuit televisions or CCTVs are extremely popular around the globe. This will provide real-time updates from different places without a painstakingly long ride to check a specific location. Thirty pcs (30) CCTVs strategically installed in place across the province, putting an extra CCTV monitoring in Candaba, Arayat, Candelaria, and Sulipan-Pampanga, which, if hit by enormous

torrential rains, will immediately affect the towns of Calumpit, Hagonoy, Malolos, Pulilan and Paombong, the viewing system at the PDRRC OpCen (Office command and Control Center), beside the installation of wireless weather stations, water level sensors in identified remote sites.

The community-based flood mitigation management program (CBFMMP) of the Pampanga River Flood Forecasting and Warning Center (PRFFWC) of the Flood Forecasting Branch (FFB) is a non-structural flood mitigating means that encompasses hydrological monitoring, information exchange and flood warning, and the disaster preparedness phases as applied to a locality or a sub-basin area within the Pampanga River Basin area, particularly the river systems within the Bulacan province. The system is composed of a network of rainfall and water level monitoring stations located strategically within the subject area and a set of (dedicated) communication equipment for data and information transfer between the monitoring stations, the municipal/barangay disaster action teams, and the operations center (provincial capitol & PRFFWC). The system shall be operated by trained municipal and barangay personnel. Presently, seven water level monitoring stations have been set up along the Angat River (the leading backup monitoring & warning points during excess reservoir releases from Angat Dam). Three other river monitoring stations cover the other active tributaries. Four rain gauge stations installed at strategic locations within the province complemented the system. Schedules for river cross-sectioning for river dynamics to handle flash flood warnings and training programs of barangay or local observers are now being planned. Although the system does not have any of that state-of-the-art technology being used nowadays, except probably the means of communication, its sustainability and continued operations shall mainly be dependent on the dedication and trust of the province in a non-structural flood mitigating system that they can operate and call their very own, and the continued support and interaction of the PRFFWC. Staff gauges installed along the Angat River at Bustos and Pulilan are considered strategic areas within the province.

Safety Regulation– Results and recommendations are discussed and acted upon. Presidential Decree (P.D.) No. 1096 Adopting a National Building Code of the Philippines (NBCP), thereby revising Republic Act No. 6541 (R.A. No. 6541). CHAPTER I: GENERAL PROVISIONS: Section 102.

Declaration of Policy- It is as a result of this declared to be the policy of the State to safeguard life, health, property, and public welfare, consistent with the principles of sound environmental management and control; and to this end, make it the purpose of this Code to provide for all buildings and structures, a framework of minimum standards and requirements to regulate and control their location, size, the design quality of materials, construction, use, occupancy, and maintenance.

Green Buildings. This is the product of sustainable design. A green/sustainable design is a design that minimizes the negative human impacts on the natural surroundings, materials, resources, and processes that prevail in nature; we need a green building to promote resource management efficiency and site sustainability while minimizing the negative impact of buildings on health and environment. SOLUTION: reduce demand + lower carbon dioxide emission; there will be many benefits in green building such as Lower business costs, increased the value of a property, conserving resources, improved air quality, improved occupant health and productivity, and finally saving the planet. The objectives of the Green Building Code are to improve the efficiency of building performance through a set of standards and counter harmful gases responsible for effects.

In adherence to the Building Code and Fire Code (PD1185), the PGB supports and assists the BFP in conducting fire Safety Inspections at the Provincial Government of Bulacan buildings.

Structural Measures- The provincial government issued MEMO-GO-2013-154, which stated the implementation of an inventory of existing critical infrastructures strictly. PDRRMC structural measures against flood in the province include construction/ repair, and maintenance of dikes, levees, and other waterways.

Provincial Legislation was necessary to ensure the safety of the responders who are the front-liners during calamities. The governor and PDRRMC Chairman issued Executive Orders to carry out measures and P/P/As on disaster management effectively. Guidelines for performing their duties as security workers were set. Existing protocols were followed to be updated regularly and meet the needs of the calamity victims.

Relocation of Informal Settler Families Living in Multi-Hazard Areas was also done. The PBG, with funding from the National Housing Authority, began a program to build new housing and relocate 835 to 1,100 Informal Settler Families currently living in high-risk areas. The program provided decent shelter to underprivileged and homeless citizens living along the Angat River and other multi-hazard zones and promoted environmental protection. With close coordination with the provincial planning and development office, LGUs in Bulacan province surveyed vulnerability (group, areas). They came up with hazards/vulnerability maps, capacity/rescue maps, and risk maps.

The vulnerable and marginalized groups were the priority of the provincial government. Vulnerable and marginalized groups included individuals or groups of people faced with higher exposure to disaster risk and poverty, including but not limited to women, especially pregnant women, youth, children, orphans, and unaccompanied children, elderly differently-abled people, indigenous groups, disadvantaged families and individuals living high-risk areas and danger zone, and those living in the road rights-of-way and highly congested areas vulnerable to industrial and environmental health hazards and road accidents. However, based on the institutional assessment of the provincial government on DRR/CCA implementation of PPAs with regard to Climate Change Adaptation, the gaps above and challenges were identified with regard to DRR.

As the saying goes, prevention is better than a cure. The RA 10121 Section 3 clearly states the need to ensure communities provide maximum care, assistance, and services to those affected by disasters. There is also a need to implement emergency rehabilitation projects to lessen the impact of calamities and facilitate a resumption of everyday social and economic activities. National Housing Authority (NHA), (2018). In line with the prevention plan, the Provincial Government of Bulacan, with funding from the NHA, began a program to build new housing for those who are not and relocate the 835 to 1,100 informal settlers' families currently living in high-risk areas. The program provided decent shelters to underprivileged and homeless citizens living along the Angat River and other multi-hazard zones to promote environmental protection. However, gaps and weaknesses were identified based on the DRRCCA report, particularly the uncontrolled informal settlement along the high danger zones (PDRRM, 2019).

Inadequate monitoring and enforcement in high-risk areas, neglect of river buffer zones, conversion of agricultural lands, and river siltation have contributed to increased flooding. Projects initiated by the Bulacan provincial government and other affected municipalities have, in some cases, exacerbated local flooding. Effective flood prevention strategies must be integrated into local development plans, particularly those related to human settlement. Relocation efforts have moved homeless families from

new urban and settlement areas to both disaster-prone and properly zoned locations. To implement prevention plans successfully, ongoing relocation from high-risk zones is necessary. Populations in these areas are primarily affected by floods, volcanic eruptions, landslides, mudslides, and rockslides. Residents in highly vulnerable locations should be resettled and subject to strict monitoring to prevent their return to disaster-prone sites.

Prevention serves as a form of preserving natural defenses. Critical environments and natural resources must be protected and conserved, as natural buffer zones mitigate the impact of natural disasters. Environmental degradation exacerbates the severity of such disasters. Effective safeguarding requires reducing trigger factors and sources that contribute to climate change, such as greenhouse gas emissions; landslides, including improper land use and deforestation of unstable slopes; and flooding, which may result from heavy siltation, obstruction of river channels, accumulation of river floodplains, and drought effects on wetlands and biotic components. Preservation efforts should also focus on improving the socio-economic status of vulnerable communities. Comprehensive risk reduction programs, increased employment opportunities, enhanced community resilience, and the provision of low-cost, affordable housing for resettled or relocated populations are essential.

The DRRCCA of the Provincial Government emphasizes sectoral strategies related to settlements and physical resources. To prioritize Bulakeños in housing resettlement, Kapasiyahan Blg. 579 was amended to address the relocation of informal settlers from Metro Manila to Bulacan. A task force on squatters was reorganized and convened under the Provincial Administrative Code (S.P. Resolution No. 605, Ordinance No. C-001, November 25, 1996). The shelter plan was developed in phases to ensure the protection of the natural environment.

The provincial government of Bulacan implemented several mitigation strategies. First, it provided continuous access to insurance and other risk transfer mechanisms. Second, it enforced building and fire codes through effective administration of regulations. Third, it strictly regulated environmental laws to reduce the adverse impacts of climate change on developers and residents. Fourth, it issued local ordinances to enhance community safety, including orders for residents to avoid disaster-prone areas and the adoption of prescribed safety measures. Fifth, it implemented engineering interventions such as constructing and maintaining dams, levees, flood control systems, drainage, and riverbank stabilization structures. Sixth, it promoted climate-resilient architectural designs, including green buildings and waterproof housing using climate-resistant materials in vulnerable areas (Cabrido, Jr., 2008).

The DRVA/CCA report identified several gaps and challenges. A key finding was the need to assess building code enforcement. The report recommended that all projects, especially those locally funded, undergo environmental impact assessments to ensure compliance. It also advised developing or promoting community-based early warning systems. Climate change management programs, plans, and activities were categorized as mitigation, adaptation, or cross-cutting measures according to CCA strategies, with adaptation measures prioritized in PDPFP mainstreaming. DRRM and CCA PPAs often overlapped in addressing related issues and challenges.

Safety and Risk Management Theory. This theory provides advanced knowledge of risk assessment techniques, fosters a positive perception of risk, and supports sound decision-making for competitiveness. It emphasizes effective safety and risk management practices, including the application of safety methodologies, ergonomics, and human factors (The Orange Book, 2004). Effective safety and risk management requires identifying, assessing, and prioritizing risks; monitoring and reporting on their management; promoting good management practices; considering legal requirements; and allocating

appropriate

resources

(DCU,

2015).

The above studies form the foundation for this research. The goal is to offer readers advanced knowledge of risk assessment techniques, foster positive perceptions of risk, and support informed decision-making for competitiveness. This research will highlight practical applications of safety methodologies and effective safety and risk management techniques. It will also address the importance of processes such as risk identification, prioritization, monitoring, and reporting.

These safety and risk management measures will be implemented using both qualitative and quantitative risk assessments. The study will focus on the management of safety within the broader context of risk management, balancing financial, quality, and environmental considerations.

Public Safety Theory. Public awareness of hazards and risks has enhanced the importance of safety assessment and management in today's increasingly litigious society. Worldwide, the burden of responsibility for health and safety is shifting towards those who own, manage, and work in the industry and commercial organizations. Legal reform replaces detailed industry-specific legislation with a modern approach where possible goals and general principles are set. The mismanagement, safety, and risk need to be integrated into the overall management of the organization. Using the onus in the organization, achieving the program objectives would be more accessible by considering appropriate and cost-effective techniques, flexible bureaucratic rules and procedures, without dampening the innovative entrepreneurial spirit of employees. An organization's exposure to potential hazards needs to be managed to reduce the chance of unsafe situations and loss of life. Risk and well-being issues need to be valued not only in a structured and calculated manner but in the light of the use of the overall organizational strategies (Klimczak & Kozminski, 2007).

Related Studies

The related studies provide valuable insights into the prevention, preparedness, and mitigation initiatives and strategies adopted to address flooding in local communities, particularly in Bulacan and other flood-prone areas of the Philippines. These studies underscore the vital role of both policy frameworks and community-based actions in reducing flood risk and strengthening local resilience.

Several studies highlighted prevention strategies to minimize flood exposure. Dela Cruz (2016) noted that many LGUs lack specialized flood preparedness and mitigation plans, and that preventive measures are often not systematically included in disaster management programs. Similarly, Jocson et al. (2019) identified clogged rivers, canals, and poor waste management as significant contributors to flooding, emphasizing the need for preventive infrastructure and proper maintenance of waterways. Prevention, therefore, involves both structural measures, such as flood control systems and drainage improvement, and non-structural measures, including community education, zoning regulations, and environmental management to reduce vulnerabilities.

Preparedness initiatives aim to ensure that LGUs and communities can respond effectively to flooding. Studies show that LGU officials and personnel are central to planning and implementing disaster risk reduction measures. Involving municipal and barangay personnel in contingency planning, as Dela Cruz (2016) suggests, enables a coordinated response that protects affected populations. Similarly, JICA (2009) highlights the importance of building local capacity to improve preparedness, ensuring stakeholders can implement flood mitigation measures and respond quickly during emergencies.

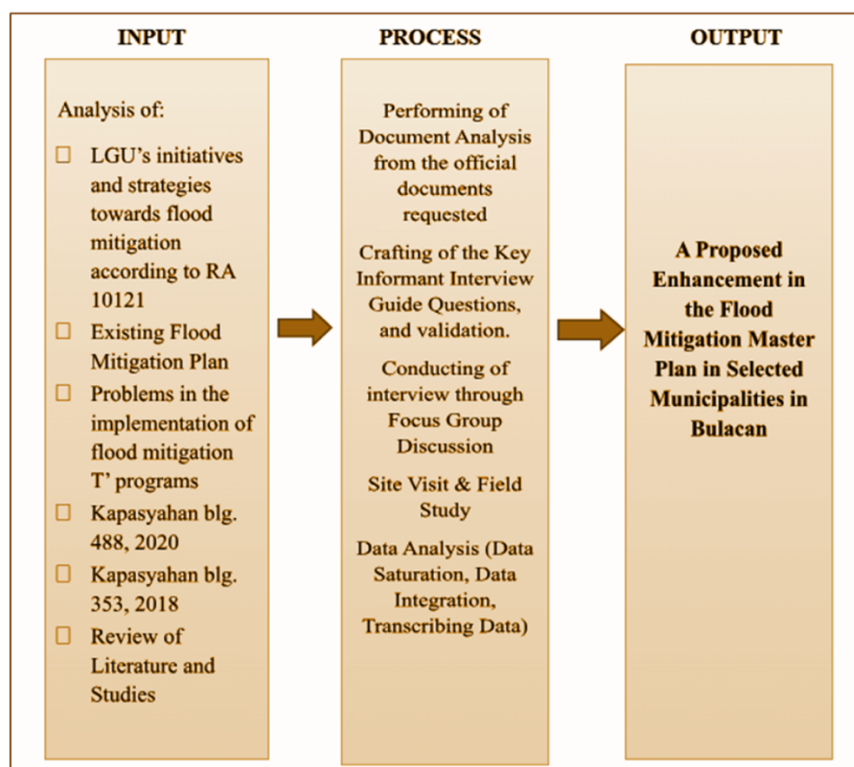
Mitigation strategies aim to reduce the severity and impact of flooding through both structural and non-structural measures. JICA's master plan combines engineered flood control with organizational and procedural improvements. Jocson et al. (2019) emphasize that effective mitigation addresses root causes, such as inadequate infrastructure and poorly maintained waterways. In Bulacan, the Local Disaster Risk Reduction and Management Fund (LDRRMF) supports projects including riverbank rehabilitation, evacuation planning, and community resilience programs. These initiatives reflect a proactive approach that integrates risk assessment, infrastructure development, and policy implementation to reduce flood impacts.

The related studies are highly relevant to the present study, demonstrating that effective flood management depends on integrated prevention, preparedness, and mitigation strategies. By exploring the experiences of LGU officials and real flood events, these studies identify best practices, gaps, and lessons that can guide Bulacan's local strategies. This study builds on that foundation by analyzing how Bulacan's flood control initiatives are planned, implemented, and evaluated, offering insight into their effectiveness in protecting lives, property, and livelihoods.

Paradigm of the Study

Figure 1 shows the study's input-process-output framework. The researcher examined initiatives and strategies used by selected Local Government Units in Bulacan to support preparation, prevention, and mitigation efforts in line with national policies, specifically Republic Act 10121.

Figure 1.
The Paradigm of the Study



The study's framework outlines the research process and its goal of supporting practical flood mitigation in selected Bulacan municipalities. The study begins with the input stage, which encompasses all the essential sources of information and foundational materials necessary for analysis. This includes the initiatives and strategies of local government units (LGUs) toward flood mitigation as guided by RA

10121, existing flood mitigation plans, and the challenges encountered in implementing these programs. Additionally, official resolutions such as Kapasyahan Blg. 488 (2020) and Blg. 353 (2018), which declare states of calamity in the province due to flooding, provide concrete case examples. A review of literature and related studies further grounds the research in established findings and best practices in disaster risk reduction.

After the input stage, the study proceeds to the process stage, which details the methodological steps taken to analyze and validate the data. This includes document analysis of official records and reports, crafting and validating key informant interview guide questions, and conducting interviews through focus group discussions with LGU officials and personnel directly involved in flood management. Site visits and field studies are also conducted to observe flood mitigation measures and community practices firsthand. The data collected are then analyzed through processes such as data saturation, integration, and transcription to ensure comprehensive and reliable findings. By combining documentary review, qualitative interviews, and field observations, the study adopts a rigorous and holistic approach to understanding both the policy and practical dimensions of flood mitigation.

The output of the study is a proposed enhancement to the Flood Mitigation Master Plan for the selected municipalities in Bulacan. This proposed enhancement aims to address the gaps and challenges identified in current flood mitigation programs, align local initiatives with national disaster risk reduction policies, and integrate best practices derived from local experiences and related studies. The paradigm demonstrates a logical flow from data collection and analysis to actionable recommendations, emphasizing that the research is not only descriptive but also solution-oriented. It highlights the importance of evidence-based planning, stakeholder engagement, and practical interventions in strengthening flood control measures and enhancing community resilience.

Methodology

This study utilized a mixed-methods research approach to provide a comprehensive understanding of flooding conditions and flood mitigation practices in selected Local Government Units (LGUs) in the Province of Bulacan. The sequential explanatory design was adopted, wherein quantitative data were collected and analyzed first, followed by qualitative data collection to contextualize and explain the quantitative findings. This design aligns with Safety and Risk Management Theory, which emphasizes systematic identification, measurement, and management of hazards, and Public Safety Theory, which supports evidence-based governance and coordinated community protection.

Quantitative Data Collection and Analysis. Quantitative data on historical and current flooding were obtained from authoritative and verifiable sources to ensure accuracy and reliability. These included flood susceptibility maps from the Mines and Geosciences Bureau (MGB) Regional Office III at a 1:10,000 scale, and records of major typhoons—Ondoy (2009), Henry, Ompong, Ulysses, and Fabian—from 2009 to 2021. Official reports and historical records were also requested from LGUs to assess flooding frequency, severity, and impacts in each locality.

Data were analyzed using descriptive statistical techniques, including frequency counts, percentage distributions, and mean computations, providing a systematic assessment of flood occurrences and mitigation measures. These analyses operationalized Safety and Risk Management Theory by quantifying hazard exposure and evaluating control measures, while supporting Public Safety Theory by generating evidence to inform risk-informed planning and decision-making.

Qualitative Data Collection and Instrument Validation. To complement the quantitative findings, a key informant interview guide was developed to capture insights into institutional practices, challenges, and community experiences. The guide was validated by disaster risk reduction (DRR) experts to ensure content validity, clarity, and alignment with the study objectives. Validation strengthened the instrument's credibility and reinforced the study's reliability and replicability.

Qualitative data were collected through Focus Group Discussions (FGDs) with selected participants in each LGU. These discussions offered valuable insights into how LGUs implemented flood mitigation strategies and emergency preparedness measures. The qualitative phase supported Public Safety Theory by emphasizing multi-level governance, stakeholder collaboration, and proactive community protection.

Sampling Design and Rationale. A purposive, non-probability sampling technique was used to include participants with direct knowledge and experience in flood mitigation. Selection criteria required participants to reside or work in the six low-lying LGUs and possess expertise in disaster risk reduction programs.

The study involved 87 participants: 27 key informants, including six (6) municipal/city officials, six (6) planning officers, six (6) C/MDRRMOs, and nine (9) rescue team leaders who participated in FGDs, and 60 local community members who responded to the survey questionnaire. This multi-level sampling captured both institutional-level perspectives and grassroots insights, reflecting Public Safety Theory's emphasis on integrating community input with formal governance structures.

Data Analysis Procedures. Quantitative data were analyzed using frequency, percentage, and mean to describe flood mitigation measures and flooding conditions across LGUs. Qualitative data from FGDs were thematically analyzed to identify patterns in institutional practices, challenges, and community experiences. Combining these methods enabled triangulation of findings, which improved validity, reliability, and explanatory depth. The approach was guided by Safety and Risk Management Theory, which focuses on systematic hazard assessment, and Public Safety Theory, which highlights informed, coordinated decision-making to protect communities.

Reliability, Replicability, and Practical Application. Methodological rigor was ensured through standardized data collection procedures, validated instruments, and consistent application of sampling criteria across all LGUs. Triangulation of survey results, FGDs, official records, and secondary data reduced potential biases and strengthened the credibility of the findings. This approach not only ensured reliability and replicability but also supported the practical application of the findings in policy formulation, emergency preparedness, and community-based disaster risk reduction.

Overall, the study's design, validated instruments, carefully considered sampling strategy, and triangulated analysis provided a robust framework for examining flood risk and mitigation practices in Bulacan. By integrating Safety and Risk Management Theory and Public Safety Theory, the methodology ensured that the study was academically rigorous while remaining practically relevant to local disaster risk reduction and public safety planning.

The study employed a 5-point Likert scale to assess the extent of implementation of flood mitigation programs in the selected municipalities, as evaluated by each LGU representative. The scale was interpreted as follows: a score of 5.00 to 4.21 indicated that a program was "Strongly Implemented"; 4.20 to 3.41 corresponded to "Implemented"; 3.40 to 2.61 represented "Moderately Implemented"; 2.60 to 1.81 reflected "Somewhat Implemented"; and 1.80 to 1.00 denoted "Not Implemented." The corresponding interpretation of each scale point is summarized in the table below, providing a

standardized framework for quantifying the LGU representatives' evaluations of flood mitigation program implementation.

Regarding the perception of the local community on the effectiveness of flood mitigation programs implemented by their respective municipalities, the study utilized a 5-point Likert scale. The scale was interpreted as follows: a score of 5.00 to 4.21 indicated that a program was "Extremely Effective"; 4.20 to 3.41 corresponded to "Very Effective"; 3.40 to 2.61 represented "Effective"; 2.60 to 1.81 reflected "Somewhat Effective"; and 1.80 to 1.00 denoted "Ineffective." The classification of scores is summarized in the table below, providing a standardized framework for quantifying community perceptions of program effectiveness and facilitating comparative analysis across municipalities.

Scale	Range	Verbal Interpretation
5	4.21 – 5.00	Extremely Effective
4	3.41 – 4.20	Very Effective
3	2.61 – 3.40	Effective
2	1.81 – 2.60	Somewhat Effective
1	1.00 – 1.80	Ineffective

For the qualitative data, the researcher transcribed interview responses and conducted thematic analysis. This widely used method enables researcher to identify and interpret participants' views, opinions, knowledge, experiences, and values from sources such as interview transcripts, survey responses, or social media profiles (Caulfield, 2021). In this study, the researcher systematically reviewed the transcribed data by familiarizing themselves with the content, coding, generating initial themes, refining and defining themes, and synthesizing the findings to accurately represent respondents' perspectives.

The data analysis involved triangulation of quantitative and qualitative data. Quantitative data were obtained through survey questionnaires administered to community members, while qualitative data came from thematic analysis of interviews conducted with LGU representatives, local officials, and disaster response personnel. These analyses focused on evaluating the effectiveness of flood mitigation initiatives and the improvement measures implemented in identified low-lying communities in Bulacan.

A key outcome highlighted in this study was the development of an enhanced Flood Mitigation Master Plan. The plan systematically assesses flood risks and identifies long-term strategies to protect human life, property, and the environment, while also promoting public awareness and community preparedness (Caulfield, 2021). Consistent with Safety and Risk Management Theory, the master plan emphasizes proactive risk assessment, hazard control, and evidence-based decision-making. In line with Public Safety Theory, the planning process actively involved stakeholders, including provincial officials, LGU representatives, local agencies, and project partners, ensuring coordinated and participatory strategies for community protection and disaster resilience.

Ethical Considerations. Participation was voluntary, with informed consent obtained from all respondents. Confidentiality and anonymity were ensured, and participants were informed that data would be used only for research.

Results and Discussion

The current Flooding Condition in the Different LGUs in Bulacan. The researcher obtained several official records and documents to clearly describe the flooding conditions in six Local Government Units in Bulacan as follows: 1) Calumpit, 2) Hagonoy, 3) Paombong, 4) City of Malolos, 5) Obando, and 6) Bulakan. Document analysis was conducted to describe, analyze, and interpret the data. Flooding conditions in these LGUs are presented in terms of: a) flooding occurrences and b) rate of flooding based on population exposure.

The flooding conditions in the different Local Government Units (LGUs) of Bulacan, as described in the document, demonstrate a clear pattern of hazard exposure, vulnerability, and risk, which are central concepts in Safety and Risk Management Theory. According to this theory, risk is a function of the interaction between hazards (e.g., typhoons, tidal flooding, river backflow), exposure (population and assets located in flood-prone areas), and vulnerability (capacity of communities to cope with flooding).

According to DENR-MGB flood susceptibility maps, all municipalities and cities in Bulacan face varying levels of flood exposure. Frequent flooding, especially in coastal and low-lying areas such as Obando, Bulakan, City of Malolos, Paombong, Hagonoy, and Calumpit, indicates chronic risk rather than isolated events. Safety and Risk Management Theory highlights the need to identify recurring hazards to support preventive and mitigation measures instead of relying solely on reactive responses.

Reported exposure rates, including 100% in Obando and over 69% in Paombong and Hagonoy, indicate systemic risk, with entire communities located in high-susceptibility zones. Despite a “low” population exposure classification, the large number of residents at risk remains a significant safety concern. Risk reduction strategies should include land-use planning, flood control infrastructure, early warning systems, and relocation programs for highly vulnerable groups.

Historical data on major typhoons, especially Typhoon Ondoy in 2009, underscores the importance of Safety and Risk Management Theory. Ondoy caused the highest fatalities and affected populations in Bulacan, highlighting the impact of inadequate preparedness and mitigation. Extensive damage to households, infrastructure, agriculture, and livelihoods, as well as economic losses exceeding Php 417 million, demonstrate how unmanaged risks can lead to large-scale disasters.

From the lens of Public Safety Theory, the flooding situation in Bulacan underscores the responsibility of government institutions to protect life, property, and social stability. Public Safety Theory focuses on the role of the state in ensuring community safety through policy implementation, disaster preparedness, emergency response, and recovery mechanisms. The repeated flooding incidents indicate a need for stronger coordination among LGUs, national agencies, and community stakeholders to strengthen public safety outcomes.

Documented evacuation efforts, the establishment of evacuation centers, and damage assessments demonstrate active public safety measures. However, recurring floods indicate the need to prioritize preventive interventions, including improved drainage, river management, coastal protection, and community-based disaster risk reduction. The backflow of floodwaters from neighboring provinces through the Pampanga River System underscores the importance of inter-jurisdictional cooperation, a key principle in Public Safety Theory, since risks extend beyond political boundaries.

The flooding conditions in Bulacan demonstrates how natural hazards, when combined with high population exposure and geographic vulnerability, create persistent safety risks. Applying Safety and Risk Management Theory emphasizes the need for proactive risk identification and mitigation, while Public Safety Theory highlights the critical role of governance, preparedness, and coordinated action in safeguarding communities. Strengthening these approaches can significantly reduce future flood-related losses and enhance the resilience of Bulacan’s LGUs.

Flood Control Mechanisms. The flood control mechanisms implemented by the Provincial Government of Bulacan and its component LGUs reflect the practical application of Safety and Risk Management Theory, particularly in the areas of preparedness, response, and risk mitigation. This theory emphasizes systematic planning, early detection of hazards, and timely interventions to minimize harm to people, infrastructure, and livelihoods. The activation of the Incident Command System (ICS), prepositioning of rescue teams, deployment of equipment, and continuous monitoring of water levels through rain gauges and water level stations demonstrate a structured and proactive approach to managing flood-related risks.

Early mobilization of resources, including the prepositioning of 304 reservists and PSWDO personnel, demonstrates risk anticipation and capacity building, both essential for effective disaster risk reduction. Real-time data from monitoring systems enables decision-makers to assess changing flood risks and implement timely response measures, reducing uncertainty and potential losses. These actions reflect Safety and Risk Management Theory's focus on evidence-based decision-making and operational readiness.

The central role of communication and warning systems across LGUs further supports this theoretical framework. The regular dissemination of advisories by Emergency Operation Centers (EOCs), coordination among DRRM Officers, Local Chief Executives (LCEs), and Barangay Emergency Response Teams (BERTs), and the implementation of Standard Operating Procedures (SOPs) for evacuation are critical risk control measures. These actions help minimize exposure by enabling timely evacuations and precautionary behaviors among residents in high-risk areas.

In relation to Public Safety Theory, the flood control mechanisms highlight the government's responsibility to protect the welfare and safety of the population through organized, coordinated, and inclusive public safety services. The establishment and activation of EOCs, the identification of high-risk barangays, and the provision of evacuation transportation and shelters, particularly by the City Government of Malolos, demonstrate institutional accountability and public service delivery during emergencies. Public Safety Theory underscores that safeguarding communities requires not only emergency response but also clear leadership, inter-agency coordination, and community engagement, all of which are evident in the described mechanisms.

The localized responses of municipalities such as Calumpit, Hagonoy, and Paombong demonstrate decentralized public safety governance. By prioritizing response sectors based on local needs, mobilizing barangay disaster councils, and using communication networks to inform residents, these LGUs apply Public Safety Theory at the grassroots level. In Hagonoy, the active involvement of the Communication and Warning Unit and BERTs in sharing flood information led to better-informed communities and fewer affected families. This result shows that effective public communication directly improves public safety and resilience.

Moreover, the consistent monitoring of water levels and adherence to SOPs across LGUs indicate an institutionalized safety culture, a key principle in both theories. Safety and Risk Management Theory views such standardization as essential for reducing human error and ensuring predictable responses, while Public Safety Theory recognizes SOPs as mechanisms for ensuring fairness, efficiency, and reliability in public service during crises.

In summary, Bulacan's flood control mechanisms exemplify Safety and Risk Management Theory through hazard monitoring, preparedness, and systematic response. They also reflect Public Safety Theory by prioritizing governance, coordination, communication, and community protection. When considered with documented flooding conditions, these mechanisms show how theory-based disaster management

can mitigate risk, reduce vulnerability, and strengthen the safety and resilience of flood-prone LGUs in Bulacan.

Based on the findings of the study, flooding in the selected Local Government Units (LGUs) in the Province of Bulacan remains widespread and persistent, continuing to affect a significant proportion of communities residing in flood-prone areas. Despite the presence of flood control mechanisms and the allocation of government funds for flood mitigation by both national and provincial governments, the impacts of flooding remain substantial. This indicates that existing measures, while beneficial, are insufficient to fully address the scale and recurrence of flood hazards in the province.

Although local governments have demonstrated preparedness through the establishment of disaster risk reduction mechanisms, the financial capacity of LGUs remains a challenge. The limited fiscal resources of local governments constrain their ability to adequately prepare for disasters, particularly in providing financial assistance, insurance coverage for affected properties, and long-term recovery support for communities. Similarly, post-disaster interventions such as road reconstruction and infrastructure development, while essential for restoring normalcy, often require sustained funding and intergovernmental support to ensure the timely recovery of affected areas.

Aligned with Safety and Risk Management Theory, the findings highlight the need for a comprehensive approach that prioritizes prevention, mitigation, and preparedness, not just response. Developing an enhanced flood mitigation plan that includes hazard assessment, exposure reduction, and vulnerability management is essential to reducing flood risks. Strengthening preventive measures such as early warning systems, land-use planning, and both structural and non-structural interventions can significantly lessen flood impacts and build community resilience.

Public Safety Theory underscores the responsibility of LGUs in protecting public welfare. Effective flood management depends on coordinated action among government agencies, private stakeholders, and communities to ensure safety throughout all phases of flooding. Focusing efforts across prevention, preparedness, response, and recovery strengthens institutional accountability and builds community trust in public safety systems.

The findings of this study underscore the urgent need for systematic, evidence-based flood risk management and the strengthening of community resilience in the Province of Bulacan. One of the most significant recommendations is the adoption and implementation of an enhanced Flood Management Master Plan by the six LGUs. Such a plan would serve as a comprehensive guide for policy formulation, infrastructure development, and emergency response, ensuring that mitigation measures are tailored to local risk profiles and coordinated across municipal and provincial levels. This recommendation aligns directly with the Philippine Disaster Risk Reduction and Management Act of 2010 (RA 10121), which mandates the integration of disaster risk reduction into local development planning, and with Presidential Decree 1566, which emphasizes community-level preparedness and hazard mitigation. At an international level, the adoption of a master plan mirrors the principles of the Sendai Framework for Disaster Risk Reduction (2015–2030), which promotes risk-informed planning and long-term strategies to reduce hazard exposure. By implementing such a plan, LGUs can ensure that flood mitigation efforts are both proactive and evidence-based, reducing human and economic losses while improving public safety.

The study further highlights the importance of strengthening institutional and community capacity to address flood hazards effectively. LGUs, in collaboration with relevant stakeholders, should enhance their disaster management capabilities, mainstream disaster risk reduction and climate change considerations into governance frameworks, and empower communities to actively participate in

mitigation efforts. These actions are supported by Sections 15–17 of RA 10121, which require the establishment of functional disaster risk reduction councils and multi-sectoral collaboration. The integration of DRRM into education, as mandated by DepEd DO 50 s.2011 and DM 112 s.2015, also ensures that youth are engaged in resilience-building activities. Internationally, these measures reflect best practices in participatory disaster governance, as recommended by the United Nations Office for Disaster Risk Reduction (UNDRR), emphasizing stakeholder engagement and community empowerment. Enhancing institutional and community capacity ensures that disaster preparedness and response are coordinated, socially inclusive, and responsive to the needs of vulnerable populations.

For disaster prevention and mitigation, the study recommends regular flood risk assessments, the development of early warning systems, and the implementation of both structural and non-structural mitigation measures.

These actions are grounded in RA 9729 (Philippine Climate Change Act of 2009), which mandates the integration of climate risk into local planning, and in PD 1096 (National Building Code of the Philippines), which establishes structural standards to reduce hazard vulnerability. Additionally, the NDRRMC Memorandum Circular No. 37, s.2018, provides guidance for LGUs in reviewing and updating their local disaster risk reduction and management plans. Internationally, these recommendations correspond with global practices in flood-prone countries such as Japan and the Netherlands, where hazard mapping, early warning systems, and structural mitigation have significantly reduced flood risks. By implementing these measures, LGUs can minimize hazard exposure, protect lives and property, and strengthen the resilience of communities.

The study also emphasizes the critical role of disaster response mechanisms. Strengthening institutional response capacities, enhancing search and rescue skills, and improving understanding of social processes during flash floods are essential. RA 10121 requires LGUs to establish disaster operations centers and contingency plans, while Joint Memorandum Circular No. 2013-1 provides guidelines for multi-agency coordination during emergencies. Internationally, these practices align with recommendations by the International Federation of Red Cross and Red Crescent Societies (IFRC), which stress rapid response, coordinated operations, and community-based engagement. Improved response mechanisms ensure that interventions during flooding are timely, coordinated, and socially sensitive, minimizing casualties and economic losses.

Regarding rehabilitation and recovery, the study recommends integrating disaster risk reduction into post-disaster processes, conducting systematic damage assessments, and implementing hazard-resilient and socially inclusive reconstruction strategies. RA 10121 mandates that rehabilitation and reconstruction projects incorporate DRR measures, while local resolutions and executive orders (such as EO 28-2001 and EO 5 s.2018) provide guidance on business continuity and recovery operations. These practices resonate with the “build back better” principle of the Sendai Framework, ensuring that recovery efforts reduce future vulnerabilities rather than reproducing hazards. By mainstreaming DRR in recovery, Bulacan can achieve sustainable, hazard-resilient development.

Finally, the study highlights the importance of future research and continuous policy learning. In-depth studies on community-based flood mitigation and locally driven DRR policy formulation can provide critical evidence for refining both LGU and national disaster management policies. This recommendation aligns with the Sendai Framework’s emphasis on data-driven decision-making and knowledge sharing, enabling benchmarking against international best practices and replication of successful strategies in other flood-prone regions of the Philippines.

Conclusion and Recommendation

Overall, the study demonstrates that localized flood mitigation strategies, when informed by data, theory, and community participation, can significantly enhance public safety, reduce vulnerability, and inform both local and national policy. By linking the findings to RA 10121, NDRRMP, climate adaptation frameworks, and international disaster risk reduction standards, the study provides a roadmap for policy-makers to implement evidence-based, participatory, and sustainable flood management strategies. Through these measures, Bulacan can serve as a model for resilient, climate-adaptive governance, bridging local action with national policy goals and global best practices.

In addition, it is recommended that LGUs, in collaboration with relevant stakeholders, strengthen both institutional and community capacities by fostering disaster-resilient communities. This can be achieved by mainstreaming disaster risk reduction (DRR) and climate risk considerations into local governance frameworks at all levels, thereby institutionalizing risk-informed decision-making and promoting long-term resilience.

For disaster prevention and mitigation, LGUs are encouraged to conduct regular and comprehensive flood risk assessments to identify vulnerable areas and populations. The development and institutionalization of early warning systems and risk assessment tools should be prioritized to support timely and informed decision-making. Increasing community participation and LGU involvement in disaster risk management is also essential, as community engagement enhances local preparedness and ownership of risk reduction initiatives. Furthermore, DRR should be mainstreamed into provincial, regional, and national development planning systems, supported by strengthened institutional and legal frameworks and functional multi-sectoral platforms. Disaster preparedness efforts should be reinforced through sustained public awareness campaigns, stakeholder dialogues, and capacity-building activities. Regular reviews of contingency plans, information, education, and communication (IEC) materials, and data-based information systems are also recommended. Integrating DRR and climate change education into school curricula, alongside the implementation of both structural and non-structural flood mitigation measures, will further strengthen preventive capacities.

With regard to disaster response, it is recommended that institutional mechanisms for response operations be further strengthened to ensure efficiency and coordination during flood events. Enhancing skills in search, rescue, and retrieval operations remains critical, particularly with a greater emphasis on understanding the social processes involved in flash flood warnings and emergency response to improve community compliance and safety outcomes.

For rehabilitation and recovery, LGUs are encouraged to mainstream DRR into post-disaster recovery and rehabilitation processes to avoid the recurrence of vulnerabilities. Conducting systematic post-disaster damage and needs assessments will support evidence-based recovery planning. Integrating DRR into social, economic, and human settlements development plans is also essential, along with reducing vulnerability through sustainable, hazard-resilient, and socially inclusive development strategies.

The findings of this study can also provide actionable insights for both local and national policymakers in the Philippines. The recommendation for an enhanced Flood Management Master Plan demonstrates the need for systematic, data-driven, and participatory flood risk management strategies. For local policymakers, particularly LGU officials, the study highlights the importance of integrating hazard mapping, historical flood data, and community input into planning, ensuring that mitigation measures are tailored to local vulnerabilities. This approach enables LGUs to prioritize resources effectively, strengthen emergency preparedness, and enhance community resilience.

At the national level, the study underscores the need to align LGU flood mitigation initiatives with overarching frameworks, such as the Philippine Disaster Risk Reduction and Management Act (RA 10121) and the National Disaster Risk Reduction and Management Plan (NDRRMP). The evidence presented can guide national agencies in identifying best practices at the local level, scaling effective interventions, and ensuring consistency in policy implementation across regions. By documenting and analyzing the successes and gaps in Bulacan's flood mitigation efforts, the study provides a benchmark for policy refinement, funding allocation, and multi-agency coordination.

When compared to international best practices, the findings resonate with strategies recommended by the United Nations Office for Disaster Risk Reduction (UNDRR) and frameworks such as the Sendai Framework for Disaster Risk Reduction (2015–2030). These frameworks advocate for: a) Risk-informed planning – using historical and projected hazard data to guide land use, infrastructure, and emergency planning; b) Community engagement and participatory governance – involving local stakeholders in decision-making to ensure socially inclusive and context-specific interventions; c) Integrated multi-level governance – aligning local initiatives with regional and national disaster management policies; and d) Evidence-based monitoring and evaluation – continuously assessing program effectiveness and adapting strategies to evolving hazards.

The study demonstrates that Bulacan's LGUs can operationalize these international principles by adopting master plans that integrate hazard assessment, public awareness campaigns, structural and non-structural mitigation measures, and community participation. For national policymakers, the findings emphasize the value of documenting and disseminating local successes as models for other flood-prone provinces, thus creating a national repository of context-specific, evidence-based interventions.

In summary, the study demonstrates that localized, data-driven flood mitigation strategies can strengthen local resilience and inform national policy. Benchmarking these practices against international standards will help the Philippines advance its disaster risk reduction framework, enhance public safety, and build climate resilience.

Finally, future research is strongly encouraged to further explore flood mitigation and disaster risk reduction efforts. Researchers are advised to undertake in-depth studies focusing on policy formulation and implementation, with particular emphasis on community-based and locally driven approaches to managing flood risks in Bulacan and other similarly flood-prone areas.

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