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## Research Article

### Flooding in Ermita: A Comparative Case Study of Before and After the Construction of the Dolomite Beach

Jan Jylyn Galvez, Andrea T. Martin, Clark Cedrick B. Sicat, John Cris V. Wenceslao, Dennis L. Estacio\*

Graduate School, Bulacan State University

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#### *\*Corresponding author:*

E-mail:

[dennis.estacio@bulsu.edu.ph](mailto:dennis.estacio@bulsu.edu.ph)

#### **ABSTRACT**

Low-lying coastal neighborhoods of Metro Manila, including Ermita, continue to struggle with flooding. Recent discussions have suggested that the 2020 Manila Bay Dolomite Beach coastal replenishment project may have made the issue worse by changing local hydrodynamics. This study used a descriptive-comparative case study design based on secondary data from peer-reviewed journal articles, government reports, academic writings, environmental assessments, and verified news articles to compare the frequency and duration of flooding in Ermita before (2015-2020) and after (2021-2025) the project's construction. High tides, severe rainfall, and inadequate drainage maintenance were the main causes of the frequent but mostly transient pre-construction floods. On the other hand, post-construction data showed more frequent and rerouted major drainage outfalls in Faura, Remedios, and Estero de San Antonio Abad as a result of artificial beach structures that reduced the effectiveness of stormwater discharge into Manila Bay. The results showed that although flooding existed before the project, the development of Dolomite Beach inadvertently decreased the urban drainage system's capacity, which prolonged Ermita's floods. In order to guarantee that environmental and aesthetic projects improve rather than jeopardize long-term resilience and public safety, the study emphasizes the vital need for thorough, multidisciplinary planning that integrates coastal engineering interventions with the current urban hydrological infrastructure.

**Keywords:** *Beach Nourishment, Coastal Engineering, Coastal Modification, Dolomite Beach, Drainage Systems, Urban Flooding*

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## Introduction

The unusual rise in water levels in places that are not frequently flooded is known as flooding (PAGASA, 2025). This is one of Metro Manila's most enduring urban issues, especially in low-lying coastal areas like Ermita. This region, which is bordered to the west by Manila Bay, has traditionally been susceptible to high tides, storm surges, and periods of heavy precipitation. A brief downpour on August 24, 2025, caused certain parts of Ermita, Manila, to flood, according to a Philippine News Agency (PNA), 2025 article. This pattern supports recorded data that the area is becoming more vulnerable to severe floods brought on by little precipitation. The city's capacity for sustainable urban management has been put to the test by the frequency and severity of periodic floods, which have led to ongoing financial losses, traffic jams, and health hazards for its citizens and commercial businesses.

However, the Department of Environment and Natural Resources (DENR) launched a rehabilitation campaign in 2020 through the Dolomite Beach coastal nourishment project in response to the declining state of Manila Bay's coastline. A 500-meter section of the bay was filled with crushed dolomite from Cebu to create an artificial beach. In order to lessen wave energy and improve the bay's scenic and recreational value, the project was marketed as a type of soft coastal engineering (Mines and Geosciences Bureau (MGB), 2020).

However, with reports of increasing flooding in several parts of Metro Manila, particularly along Taft Avenue and other major arteries, the project sparked a great deal of controversy. The Metropolitan Manila Development Authority (MMDA) notes that Dolomite Beach may have changed stormwater flow and decreased the effectiveness of drainage systems that discharge into Manila Bay, which is why flooding is getting worse, according to a July 2025 Pinoy Publiko news article. The MMDA also noted that floodwaters drained more slowly during strong typhoons and times of intense rainfall than they did prior to the beach's construction. However, the Dolomite Beach project neither caused nor exacerbated flooding in Metro Manila, according to the Department of Environment and Natural Resources

(DENR), which has refuted this claim. Rather than coastal rehabilitation efforts, the organization believes that prolonged heavy rainfall, high tide events, obstructed drainage systems, and excessive urban runoff are the main causes of the flooding. Government agencies' differing viewpoints highlight the need for an unbiased scientific evaluation of the possible impacts of coastal changes, like Dolomite Beach, on the dynamics of inland flooding.

In light of these divergent opinions, the purpose of this study is to compare the frequency of flooding in Metro Manila, particularly in Ermita, before and after Dolomite Beach was built. This study aims to ascertain whether there is a discernible shift in flood frequency or severity associated with the coastal modification of Dolomite Beach by looking at typhoon events that impacted Metro Manila and analyzing rainfall and flood data over two time periods (pre- and post-construction).

### **Statement of the Problem**

In Metro Manila, flooding is a common problem. Concerns about how the Dolomite Beach development would affect local flooding have surfaced recently. By examining data from times before and after the project's construction, the study seeks to assess the impact of the coastal development project on flooding incidences. The findings are meant to offer evidence-based approaches for managing urban and coastal floods in Manila and other coastal cities of a similar nature.

### **Objectives of the Study**

Based on a trustworthy secondary source, this study attempts to ascertain how the construction of Dolomite Beach along Manila Bay has affected flooding conditions in Ermita, Manila. It aims to give a comparative case study understanding of the area's flooding behavior prior to and during the project's implementation. Specifically, it seeks to:

1. Identify and describe the flooding conditions in Ermita, Manila, before the construction of the Dolomite Beach.
2. Examine the secondary data of the flooding conditions in Ermita, Manila, after the construction of the Dolomite Beach.

3. Assess the extent of change and overall impact of the Dolomite Beach project on flooding conditions in Ermita, Manila.

### ***Scope and Delimitation***

This analysis only analyzes secondary data from reliable news sources, technical reports, environmental evaluations, and research publications that have already been published between 2015 and 2025. It will also exclude hydrological simulation, numerical flood modeling, and primary data collection. Additionally, only flooding episodes associated with drainage, rainfall, and coastal interactions are included in this analysis. Although acknowledged, the socioeconomic and political debates surrounding the Dolomite Beach project are not thoroughly examined. Pre-construction (2015–2020) and post-construction (2021–2025) eras are included in the comparative period.

### ***Significance of the Study***

This study is important because it will shed light on the ways in which large-scale coastal modification projects, like the Dolomite Beach, might affect the behavior of flooding in neighboring areas. Many stakeholders will find this study to be important.

The study offers evidence-based observations for civil engineers and urban planners that help direct the planning and assessment of upcoming coastal engineering and flood mitigation projects in the Manila Bay region and other comparable low-lying metropolitan areas.

The results could be used as a scientific guide by environmental organizations and legislators when reevaluating the long-term environmental effects of beach nourishment and reclamation projects.

This work adds to the expanding corpus of research in academia that looks at the hydrological consequences of human activities in coastal regions.

### ***Related Literature and Studies***

#### ***Agency Conflict over the Dolomite Beach Project***

The hyper-density of the City of Manila greatly exacerbates long-term urban problems including floods and drainage management in

addition to driving the demand for recreational space. The Metropolitan Manila Development Authority (MMDA) has clearly linked the Dolomite Beach project to making the city's flooding issue worse.

The possible influence of significant infrastructure projects on Metro Manila's flooding issues has been highlighted by disputes between government entities. In particular, the fine dolomite sand choked the urban drainage systems, according to the MMDA, which oversees pumping stations and flood management in Metro Manila. Three important drainage outfalls—Faura, Remedios, and Estero de San Antonio Abad—were blocked by the man-made shoreline project, forcing water through a sewage treatment facility that couldn't manage the extra volume during periods of high precipitation. The MMDA claims that this rerouting and the overflow that followed increased flooding in Manila and the neighboring areas.

The Department of Environment and Natural Resources (DENR) refuted this assertion by attributing the severe floods to both a notable increase in rainfall and climate change, and they asked for a "science-based analysis" to settle the disagreement. The DENR acknowledged the MMDA's accusations and pledged inter-agency cooperation without outright disputing them.

This public dispute draws attention to a significant infrastructure-related dispute that lies at the core of the physical interference at the research location. High-profile restoration initiatives are politically required to show good administration because of the enormous population concentration, which naturally amplifies environmental stressors, especially with regard to home sewage discharge and surface runoff onto Manila Bay.

#### ***The Economic and Social Costs of Flooding in Metro Manila***

Metro Manila's excessive flooding has resulted in significant economic and social consequences by highlighting the city's design, infrastructure, and catastrophe resilience vulnerabilities. According to an analysis of the flooding event, direct destruction costs are expected to be between P41 billion and P55 billion (Mendoza, 2025). This includes demonstrable harm

to residential and commercial buildings, public infrastructure, transportation networks, and health-related costs resulting from relocation and outbreaks of waterborne diseases. Since flooding in the capital is a complicated, human-caused problem, these numbers not only quantify the immediate physical damage but also highlight the structural flaws in the current flood control systems, many of which have been reported as failing despite significant prior investment (Mahar Lagmay, 2025).

The inefficient use of resources in flood control initiatives has been noted as a major problem. Even though the National Capital Region received a significant P52.66 billion for flood prevention, many of the P545.6 billion that was spent countrywide between 2022 and 2025 were found to be inadequate or to lack adequate accountability (Soriano, 2025). Many see this financial load as an obvious necessity for strategic governmental reform centered on improved urban resilience, climate adaptation, and open administrative procedures. These findings echo historical warnings, as previous events often cited as deadly have offered comparable reminders of the critical economic and human toll of inadequate preparedness.

Lagmay added that the way people have changed the landscape over time is mostly to blame for the flooding issue. When floodwaters block roadways, traffic accumulates and can essentially stop people from moving about the city. There are two types of floods in Metro Manila: those that endanger lives and those that mainly impede traffic. According to a study by the Japan International Cooperation Agency (JICA), traffic bottlenecks brought on by flash floods caused by thunderstorms cost P2.4 billion every day in lost economic production and gasoline.

### ***Impacts of Beach Nourishment using Dolomite Sand***

Unlike regular beach nourishment, the controversial choice to use dolomite sand in the Manila Bay project raised special environmental and health issues. Dolomite is a naturally occurring substance that poses no immediate danger of cancer to humans, but its transportation and existence within the marine system cause ecological concerns (GeologyScience, 2023). Its

erosion and wash-off, according to critics, are functionally equal to dumping foreign sediment, perhaps burying delicate marine habitats, lowering the water's dissolved oxygen content, and blocking sunlight that aquatic plants depend on.

Beyond the content, the project's own necessity has been questioned. Scientific observers concluded that the nourishment was largely unnecessary because the Manila Bay shorelines were already protected by seawalls and breakers. Instead of using artificial, transient improvements, they advise concentrating on supporting natural processes to restore ecological integrity (IESM UP Diliman, 2020).

According to published research, beach nourishment is mainly helpful only in situations when there is significant coastal erosion. To ensure cost-effectiveness and minimal environmental harm, extensive research and simulations must be conducted prior to implementation.

### ***The Interplay of Coastal Nourishment, Infrastructure, and Governance***

Due to its perceived environmental superiority over hardened structures, beach nourishment is a well-established soft engineering technique to shoreline management that is preferred worldwide. This technique's primary advantage is its capacity to provide a broad, sandy buffer that disperses wave energy, offering robust storm protection and minimizing flood damage to upland infrastructure (Staudt et al., 2021).

A significant technological flaw in the integration of coastal defense with urban hydrological infrastructure is brought to light by the dispute surrounding the Manila Bay project. Shoreline modifications must take into account the current municipal water flow in order for coastal engineering to be effective (NEPA Report, 2019). Additionally, the project turned into a hotspot for governance and policy shortcomings in terms of prioritizing and regulatory compliance. The scientific community instantly questioned the choice to employ dolomite sand, a novel and alien substance, pointing out that its erosion and wash-off may be compared to dumping foreign silt into the bay, potentially

endangering aquatic life and raising water turbidity.

Opponents claimed that the project, which was meant to be an aesthetic improvement, was incompatible with the court-mandated priority of enhancing water quality and that it was started without an Environmental Impact Statement (EIS), which is a prerequisite for such extensive interventions (Bucay et al., 2022).

### **Research Design**

In order to assess the flooding conditions in Ermita, Manila, both before and after the Dolomite Beach was built, this study used a descriptive-comparative case study design. Using the available papers, the descriptive-comparative design examined how flooding behavior, drainage performance, and coastal conditions changed between the pre-construction and post-construction stages. Secondary data from published publications, official documents, and scholarly research were used in the study. This research design is appropriate because it did not involve direct field observations, instead concentrating on evaluating published findings and existing information. In order to provide a solid foundation for evaluating the effect of the Dolomite Beach construction on flooding in Ermita, Manila, this method allowed for the methodical description of the similarities and differences between the flooding incidents in the two time periods.

### **Research Locale**

The heavily populated City of Manila, the Philippine capital, is where the research site is located. According to the Philippine Statistics Authority's 2020 report, Manila is a highly populated coastal city on Luzon Island's west coast that is heavily bounded by Manila Bay. Since the demands placed on the nearby marine ecology are among the highest in the world, the area's significant concentration of infrastructure and human activity establishes the basic premise for studying coastal management.

The city's unique demographic composition highlights the need for rigorous environmental intervention, as the Manila Bay Dolomite Beach project. Crucially, the city's land area is limited

to 24.98 square kilometers. There is an extraordinary population density as a result of both the enormous population and the restricted physical space. Manila's population density was 73,920 people per square kilometer in 2020. With a 3.73% increase from the 2015 density of 71,263 people per square kilometer, this density confirmed Manila's ranking as one of the most densely inhabited urban areas in the world.

### **Research Instrument**

Twenty-five (25) publications and documented studies pertinent to flooding episodes and coastal management in Ermita, Manila, served as the main research tool used in this study. In order to comprehend how coastal modification projects can affect an area's flood behavior, this secondary data provided the fundamental foundation for data collecting and analysis. Peer-reviewed journal papers, government studies, scholarly works, environmental evaluations, and verifiable news stories about flooding, drainage systems, coastal development, and sediment dynamics in the

Manila Bay region are examples of secondary sources. In order to show the changes during the Dolomite Beach's pre- and post-construction phases, references published between 2015 and 2025 were chosen based on their timeliness, relevance, and credibility. Tabloid secondary data sources, non-academic articles and stories, and unconfirmed government agency papers were not included. Based on the veracity, consistency, and factualness of the contents, data sources were triangulated.

### **Data Gathering Procedure**

A thorough evaluation of secondary sources, including peer-reviewed journal papers, government reports, academic publications, environmental assessments, and verifiable news items about flooding and coastal changes in Ermita, Manila, provided the data for this study. The materials chosen were those that were released between Dolomite Beach's preconstruction (2015–2020) and postconstruction (2021–2025).

The researchers meticulously located, examined, and extracted data pertinent to the

goals of the study, especially on coastal conditions, drainage efficiency, and flooding behavior. All of the data was arranged into comparative groups that corresponded to the two eras. This procedure will offer a thorough basis for evaluating the impact of the Dolomite Beach nourishment project on flooding conditions in Ermita, Manila.

### **Data Analysis**

A documentary analysis method will be used to examine the information to be gathered from secondary sources. This would allow the researchers to analyze and qualitatively interpret information about flooding and coastal conditions in Ermita, Manila, before and after the Dolomite Beach development from previously published papers, academic studies, and official documents. Changes in coastal morphology and behavior, drainage system performance, and flooding frequency and extent will be the main focus of the analysis.

Statements, conclusions, and findings about flooding behavior and coastal change will be retrieved from each chosen document. After that, these data will be arranged into the project's two comparison phases. To find and categorize recurring concepts, insights, and published results in the literature, the researchers will employ thematic coding. The data will be coded, classified, and then synthesized to show the relationships between the creation of Dolomite Beach and the flooding conditions. This analysis attempts to create a thorough story describing how the beach nourishment project might have impacted the flooding conditions in Ermita, Manila, by contrasting several reliable accounts and studies.

### **Results and Discussion**

The flooding conditions in Ermita, Manila, before and after Dolomite Beach was established along the Manila Bay coastline are compared in this chapter. In order to clarify the variations in flooding frequency, drainage efficiency, and coastal dynamics between two periods—pre-construction (2015–2020) and post-construction (2021–2025)—the analysis looks at secondary data from peer-reviewed

journal articles, government reports, academic writings, environmental assessments, and verified news articles.

### ***Flooding Conditions Before the Dolomite Beach Construction (2015–2020)***

Flooding in Ermita was a persistent and well-documented issue in Metro Manila prior to the Dolomite Beach project's implementation. According to PAGASA (2025), the city is especially vulnerable to storm surges, heavy precipitation, and tidal inundation because to its low elevation, flat geography, and proximity to Manila Bay. Rather than changes to coastal areas, the main causes of flooding at this time were blocked drainage systems, poor solid waste management, and limited pumping capacity.

The main routes for stormwater discharge into Manila Bay were the drainage outfalls, such as Faura, Remedios, and Estero de Antonio Abad. Despite their limited capacity, these outfalls functioned without much hindrance, allowing floods to subside a few hours after precipitation events. Unaffected by outside coastal activities, research by Mendoza (2025) and Lagmay (2025) revealed that the ongoing flooding was a sign of poor urban planning and poor maintenance of flood control measures.

During this time, Metro Manila suffered flood-related damages worth billions of pesos. Mendoza (2025) estimated that annual flood damages, including public health problems, transportation disruptions, and infrastructure damage, would be between 41 billion and 55 billion. However, prior to 2020, Ermita's coastal drainage system showed no discernible hydrological alterations despite these losses.

The flooding pattern was mostly predictable and constant; it mostly happened during periods of heavy precipitation or monsoon, and it subsided as the tides decreased.

Ermita experienced frequent but brief flooding episodes prior to 2020, which were primarily caused by natural hydrological constraints and poor drainage maintenance. Because of the open coastal environment, runoff was able to discharge into Manila Bay almost continuously.

### ***Flooding Conditions After the Dolomite Beach Construction (2021–2025)***

Significant changes in the flooding patterns of Ermita and surrounding areas were seen following the completion of the Dolomite Beach project in 2020. According to Pinoy Publiko (2025), the Metropolitan Manila Development Authority (MMDA) noted a rise in the frequency and duration of floods, particularly along Taft Avenue, Padre Faura, and other low-lying neighborhoods.

Three major drainage outfalls—Faura, Remedios, and Estero de San Antonio Abad—were apparently blocked or restricted by the artificial coastline, which caused alterations in stormwater flow, according to the MMDA. The sewage treatment plant was unable to handle large intakes during periods of heavy rainfall, therefore the floodwaters that had previously flowed straight into Manila Bay were directed through it. As a result, rainfall flooded nearby cities and roads, prolonging the flood recession and deepening the inundation.

The claim that flooding was directly caused by Dolomite Beach was denied by the Department of Environment and Natural Resources (DENR), which attributed the main causes to urban runoff, significant rainfall, and climate change. However, the addition of crushed dolomite material changed coastal dynamics, perhaps affecting drainage flow and sediment deposition at outfalls, according to the IESM (2024) study. Dolomite particles may have increased turbidity and siltation during high-tide events because they are less cohesive and more granular than natural sand.

The bay is still a dynamic ecosystem that supports fish, coastal animals, and vital biological processes, according to Oceana (n.d). The problem is that continued "dump-and-fill" activities, such as the creation of the dolomite beach and many reclamation projects along the shoreline, are endangering this remaining lifespan. Natural habitats that have historically functioned as fish nurseries and coastal buffers are replaced by these activities. The bay's ability to absorb hazards is reduced by the burial and conversion of these areas into artificial land.

Adjacent towns may therefore be more vulnerable to flooding, storm surges, land subsidence, and other climate-related consequences. Furthermore, according to GeologyScience (Mahmut, 2023), dolomite's physical characteristics may alter the oxygen equilibrium and water clarity, which would have an indirect impact on nearshore hydrodynamics. Inadequate technical coordination between coastal engineering and urban flood management may have made local flooding conditions worse in the post-construction phase, as evidenced by the absence of a thorough Environmental Impact Statement (EIS) prior to project implementation (Bucay et al., 2022).

### ***Comparative Discussion: Before and After Construction***

A comparative synthesis of results indicates distinct variations in the magnitude, duration, and characteristics of flood in Ermita between the two phases:

<b>ASPECT</b>	<b>Before Dolomite Beach (2015 - 2020)</b>	<b>After Dolomite Beach (2021 - 2025)</b>
Primary Flood Cause	Flooding was primarily due to heavy rainfall, high tides, and drainage construction from solid waste and siltation. (PAGASA, 2025; Lagmay, 2025)	Flooding was reported to be aggravated by altered stormwater flow and restricted drainage outfall blocked by the Dolomite beach structure. (Lagbas, 2018); (MMDA, 2025)
Flood duration	Floodwaters typically receded within hours once rainfall stopped due to open outfalls directly discharging into Manila Bay. (Mendoza, 2025)	Floodwaters reportedly persisted longer, sometimes lasting several hours or more, as observed along Taft Avenue and Padre Faura. (Perez, A. M. P, 2024). (Principe, M, 2023)
Drainage System Condition	Pre-construction drainage outfalls such as Faura, Remedios, and	Post-construction, these same out-

ASPECT	Before Dolomite Beach (2015 - 2020)	After Dolomite Beach (2021 - 2025)
	Estero de San Antonio Abad were operational and directly connected to the bay. (Lagmay, 2025)	falls were partly blocked or redirected toward a sewerage treatment plant with limited capacity, reducing discharge efficiency. Pinoy Publiko, 2025).
Flood Depth and Intensity	Shallow to moderate flooding commonly occurred during strong rainfall but would subside quickly. (Mendoza, 2025)	Moderate to deep flooding was reported, with slower recession attributed to physical changes in coastal drainage and sediment accumulation near outlets. (IESM, 2024; Mahmut, 2023).
Environmental Condition	The coastline consisted of natural sand and open water flow with minimal artificial intervention. (MGB, 2020)	The introduction of dolomite material modified sediment dynamics, possibly affecting outflow and near-shore turbidity. (IESM, 2024; Mahmut, 2023)
Institutional Observation	Agencies focused on poor drainage maintenance and insufficient infrastructure funding as the main causes of flooding. (Mendoza, 2025; Soriano, 2025)	The MMDA emphasized the hydrological impact of the Dolomite Beach on blocked drainage outfalls, while the DENR attributed flooding to external factors like rainfall and tide. (Pinoy Publiko, 2025)

The figures show that flooding occurred in Ermita before Dolomite Beach was constructed, but since then, floods have been more frequent and severe. Two crucial technical factors that distinguish the post-construction flooding scenario are the physical obstruction of drainage outlets and the modification of stormwater flow.

The shift aligns with the findings of Staudt et al. (2021), who claimed that beach nourishment and other soft engineering solutions are only sustainable when integrated into local drainage and hydrological systems. Inadequate interagency cooperation between coastal and urban engineers plagued the Manila Bay project, resulting in both functional inefficiencies in flood management and advantages in terms of aesthetics and coastal protection.

Urban Flooding Theory explains that flooding occurs when the capacity of drainage systems is exceeded by rainfall, runoff, or external water sources. In densely developed cities, impervious surfaces such as roads, buildings, and pavements reduce natural infiltration, increasing surface runoff.

Ermita is characterized by high levels of urbanization, which contribute to rapid stormwater accumulation. The theory emphasizes that changes in coastal infrastructure may either alleviate or exacerbate flooding depending on how they interact with existing drainage systems. If coastal modifications influence outflow points, tidal backflow, or stormwater discharge into Manila Bay, they may alter local flood conditions.

This theoretical perspective provides a framework for comparing flood frequency, duration, and severity before and after the construction of the Dolomite Beach.

### Summary of Findings

The comparison results show that whereas post-construction flooding demonstrates a more complex interaction between coastal modifications and urban drainage systems, pre-construction flooding was primarily caused by natural and infrastructural limits. Despite being intended as an environmental and tourism project, the Dolomite beach project interfered with natural water flow patterns

and blocked drainage outputs, causing lengthy and severe flooding in Ermita.

The MMDA and IESM agree that in order to prevent similar consequences, future coastal projects need to be thoroughly hydrologically assessed. The findings highlight the need for coordinated coastal and urban flood control, ensuring that environmental rehabilitation projects enhance rather than compromise public safety and drainage effectiveness.

## Conclusion

Sufficient information was obtained from a comparative case study of peer-reviewed journal papers, government reports, academic writings, environmental evaluations, and verified news items about flooding conditions prior to and following the development of Dolomite Beach along the Manila Bay shoreline. According to the aforementioned secondary data, flooding happened in the area before the project, but after it was built, the frequency and length of flooding increased.

Natural hydrological limitations, inadequate drainage upkeep, and urban congestion were the main causes of Ermita's flooding pattern prior to construction (2015–2020). These elements played a part in the regular but brief flooding episodes in Ermita, Manila, which were successfully controlled by the drainage networks along Faura, Remedios, and Estero de Antonio Abad. On the other hand, flooding behavior changed significantly after construction (2021–2025) due to physical changes to the shoreline and partial blockage of important drainage outlets, which limited outflow capacity and changed stormwater discharge toward Manila Bay. According to the findings, the Dolomite Beach project altered the local hydrodynamics, impeding stormwater flow and causing extended floods in low-lying regions like Taft Avenue and Padre Faura. Technical literature notes that the absence of technical cooperation between coastal engineering improvements and urban drainage management further exacerbated the flooding problem, despite government agencies identifying climate change and severe rainfall as the primary causes.

Although the Dolomite Beach project in Manila Bay was intended to encourage tourism

and environmental rehabilitation, it inadvertently interfered with natural water flow, which decreased the efficiency of local flood control and increased the area's susceptibility to floods. The findings demonstrate the necessity of integrating hydrological modeling, coastal engineering, and urban drainage development in the planning and execution of sustainable coastal development.

In the end, our study highlighted that an engineering approach to coastal development is just as important for effective flood risk reduction in Metro Manila as improvements in drainage infrastructure and climate adaptation strategies. To make sure that future coastal modifications increase rather than decrease the flood resilience of neighboring towns, they must undergo thorough hydrological and environmental impact evaluations.

## Recommendation

In order to better evaluate the effects of reclamation projects and man-made coastal structures (like dolomite beach) on flooding, coastal vulnerability, and marine biodiversity, future research should concentrate on long-term monitoring of Manila Bay's ecological and hydrological conditions.

Engineers and planners should give sustainable, natural solutions (such mangrove and wetland restoration) precedence over man-made structures when promoting environmental restoration and tourism. By strengthening natural coastal defenses, these interventions can lower the likelihood of land subsidence, flooding, and storm surges.

Before approving reclamation or coastal development projects, the government should enact more stringent environmental restrictions and carry out thorough impact assessments. Since strategic planning and monitoring can help prevent long-term environmental degradation and improve climate resilience, policies should make sure that infrastructure does not jeopardize ecosystem health or the safety of communities in coastal areas.

Finally, in order to safeguard the natural riches of Manila Bay, local communities should actively engage in coastal management and conservation programs. Residents can be em-

powered to participate in disaster risk reduction initiatives through awareness campaigns and active engagement.

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