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Integrated Disaster Risk Reduction and Management Action Plan on Flood-Induced Industrial Hazards and Public Health Risks in the Municipality of Bauan, Batangas

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Abstract:

This study developed an Integrated Disaster Risk Reduction and Management (DRRM) action plan for Bauan, Batangas, focusing on flood-induced industrial hazards and associated public health risks in the barangays of Sta. Maria, San Roque, and San Miguel. Bauan is exposed to recurring flooding while hosting numerous industrial establishments creating conditions for Natural Hazard Triggering Technological Disasters (Natech). Using a descriptive mixed-methods research design, the study employed survey questionnaires, document analysis, situational analysis, SWOC and PESTEL analysis to assess the community's level of awareness, preparedness, response capacity, and recovery mechanisms relative to the above-mentioned hazards. Findings revealed that while the community generally demonstrates awareness and preparedness toward flooding, significant gaps related to hazardous material releases and exposure, and contamination of floodwaters remain. Based on these findings, a multi-sectoral action plan was formulated across the four thematic areas of prevention and mitigation, preparedness, response, and rehabilitation and recovery. The plan aims to strengthen industrial safety assessment, improve emergency coordination, enhance HazMat capability, build community awareness, and institutionalize long-term resilience measures. The study emphasizes the need to integrate flood-induced industrial hazards into local DRRM planning to reduce risks, protect public health, and improve municipal resilience in Bauan, Batangas.

Keywords — **Integrated Disaster Risk Reduction and Management, Flood-Induced Industrial Hazards, Public Health Risks, Bauan, Batangas, Natech**

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I. INTRODUCTION

Bauan, a first-class, highly industrialized coastal municipality in Batangas (CALABARZON), faces a compounding hazard: floods that trigger industrial accidents, a phenomenon internationally termed Natech (Natural Hazard Triggering Technological Disaster). The World Health Organization identifies four mechanisms by which floods cause chemical releases — displaced or ruptured storage tanks and pipework, power failures that disable safety controls, toxic runoff into waterways, and overflow of plant drainage carrying chemical waste. Resulting health impacts include chemical burns and poisoning, respiratory injury, contaminated food and water,

carbon-monoxide poisoning from generators, and psychosocial trauma.

This risk is not theoretical: in November 2023, a chemical spill of Solvent Naphtha L in Barangay San Miguel reached coastal waters, contaminated 6,000 square meters, caused fish kills, and forced the evacuation of 248 individuals to an open parking lot rather than an enclosed evacuation center, since toxic fumes made standard shelters unsafe. The incident demonstrated that flood evacuation protocols differ sharply from HazMat evacuation protocols, including the need to track wind direction and chemical plume drift before designating safe zones.

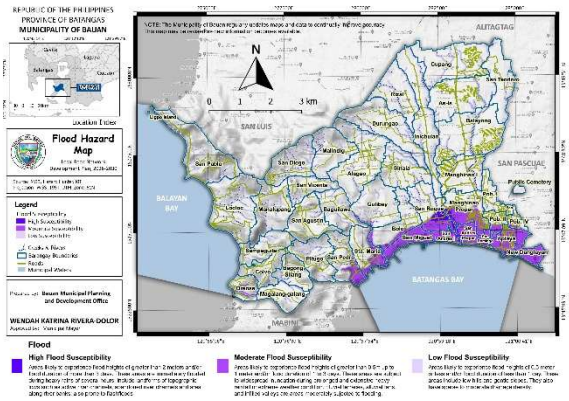

Fig. 1 Flood hazard map of Bauan, Batangas

There are 40 barangays in the municipality of Bauan distributed into three homogeneous ecological units: lowland (11), upland (16), and coastal (13). There are barangays situated in low-lying coastal and flood-prone areas that are also residential communities. These barangays are Sta. Maria, San Miguel, San Andres I, San Andres Proper, Sto. Domingo, Aplaya, and portions of San Roque and San Pedro. Evidenced by the records from Bauan MDRRMO, three among these barangays are most vulnerable to flooding, which include Sta. Maria, San Miguel, and San Roque.

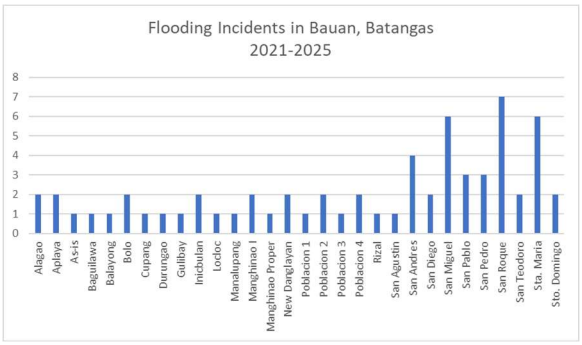

Fig. 2 Flooding incidents in Bauan, Batangas

Based on the MDRRMO historical data of flooding incidents in Bauan, from 2021-2025, it shows that 10 typhoons affected the municipality, namely, Jolina (2021), Karding (2022), Paeng (2022), Goring (2023), Carina (2024), Kristine (2024), Pepito (2024), Crising-Dante-Emong (2025), Nando (2025) and Opong (2025). San Roque was flooded by 7 out of those 10 typhoons, while San Miguel and Sta. Maria were flooded by 6 out of those 10 typhoons.

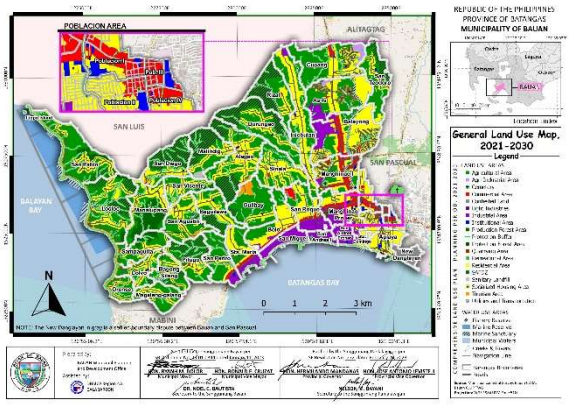

Fig. 3 General Land Use Map of Bauan, Batangas

Flood Hazard and General Land Use Maps confirm that these industrial sites overlap directly with dense residential areas, creating cascading risk. The plan was developed to operationalize a multi-sector, community-based DRRM framework — anchored in RA 10121 (Philippine DRRM Act of 2010) and the Sendai Framework 2015–2030 — covering prevention/mitigation, preparedness, response, and recovery for flood-induced industrial and environmental health emergencies.

The study utilized a descriptive research design using a mixed-methods approach to analyze vulnerability, knowledge, preparedness, response

capability, and recovery mechanisms of selected barangays of Bauan, Batangas, on flood-induced industrial hazards and public health risks. This study employed a proportional sampling and random sampling method, involving 68 respondents from barangays that are highly prone to flooding and where industrial facilities are situated. The selection of these barangays was based on their level of exposure to hazards, which makes them relevant for understanding disaster impacts and resilience.

A Likert scale questionnaire was utilized to measure key indicators such as Disaster Awareness and Prevention, Disaster Preparedness, Disaster Management and Response, and Disaster Recovery and Rehabilitation. Open-ended questions gathered residents' personal views, experiences, and recommendations. These qualitative replies added to the quantitative results by giving further insight into the human side of disaster events. Thus, the combined results provide a more comprehensive view of the public's perception and reactions to catastrophes, giving practical information that can guide local governments in enhancing their disaster preparedness and resilience programs in Bauan.

In the quantitative part, the researcher analyzed the hazard statistics, demographic data, and the structured responses of the respondents to the survey. The level of community knowledge, preparedness, disaster response, recovery capacity, and engagement in the identified barangays was determined by statistical approaches such as frequency distribution, percentage, and weighted mean. The qualitative component was designed to gather viewpoints of interested parties, including local government officials, disaster response workers, and community leaders. Data were collected through interviews, analysis of documents, and interactive discussions. This approach assisted the researcher in knowing more about the institutional capacities, coordination mechanisms, and problems in the implementation of the disaster risk reduction program.

II. SITUATIONAL ANALYSIS

Philippines, a country rich in natural resources but a very vulnerable archipelago sitting directly in the sight of nature's most deadly forces. It is a place where industrial ambition, rapid economic growth and dense coastal populations exist alongside an environment that faces an average of 20 typhoons a year, lies directly on the Pacific Ring of Fire and is experiencing a rapidly changing climate. The landscape has been altered in the last few decades by the addition of a second layer: increasing industrialization. Heavy industrial centers, chemical factories, petroleum refineries, and huge storage depots have been established throughout CALABARZON (particularly Batangas and Cavite), Central Luzon, and Metro Manila. Due to the country's distinctive terrain, these facilities are nearly always placed close to water – coasts, river basins or bays – to make shipping and transporting goods easier. When a natural disaster occurs, it strikes both the people and these industries at the same time.

What makes Natech in the Philippines particularly harmful is proximity. The inclusion of Natech in local disaster preparedness (via the OCD and NDRRMC, for example) is not an academic exercise; it is a question of survival. This means that local governments can no longer regard "industry" and "disaster risk" as two independent chapters in their Comprehensive Land Use Plans (CLUPs). For the Filipino people, sustainability in its truest sense implies that as the nation creates its economic future, its factories are built to resist the worst of nature's elements. The next major typhoon will come, and the folks taking refuge in their homes should only have to worry about the rising rain, not if a chemical nightmare is floating down their street.

When you look at the map of the CALABARZON area, Batangas is seen as an industrial gateway across different regions. It has developed from a province with a focus on agriculture to a bustling center of heavy industry and logistics. Batangas International Port, a large deepwater port, is the province's main alternative to the congested ports of Manila, so here is the shoreline where heavy industry naturally gathered. Shipping is the lifeblood of world trade. Batangas is indeed the power center of Luzon. It has big oil refineries, vast petrochemical complexes and big liquefied natural gas (LNG) power plants (covering Batangas City, San Pascual and Bauan).

Unfortunately, these industrial facilities are situated right next the residential areas.

Bauan, Batangas has 40 barangays, however its vast economic strength is moderately concentrated. That its main source of income moves from traditional agriculture or fishing to the business sector. Bauan's access to Batangas Bay and its shoreline make some barangays prime real estate for heavy industry. Sta. Maria, San Roque and San Miguel, barangays situated in the coastal area hosts a total of 30 industrial establishment with varying production activities. These facilities involve heavy marine engineering and steel fabrication, chemical storage and petroleum/gas logistics. The industrial activities are so diversified that the types of threats are as varied. One plant might have very flammable liquid gases while the other might be processing corrosive chemicals. These are home to important taxpayers and employment drivers, from huge shipyards such as the Batangas Shipyard Corporation to private port facilities like the Bauan International Port, and industrial gas plants and fabrication yards.

A perception survey across the three priority barangays found generally strong awareness and confidence regarding ordinary flooding: residents strongly agreed they understood flood causes and effects, knew evacuation routes (WM 3.69) and early warning systems (WM 3.47), and rated LGU debris-clearing and rescue capacity highly (WM 3.75 and 3.65). Disaster recovery indicators were also rated positively, particularly the LGU's debris-clearing capacity (WM 3.57) and provision of psychosocial support (WM 3.03).

However, awareness and preparedness collapsed for the industrial/chemical dimension of risk. Residents disagreed that they understood the effects of damaged chemical tanks and pipelines (WM 2.43), floodwater chemical contamination (WM 2.37), or knew whom to contact during a chemical spill (WM 2.44). Only a minority of households had emergency Go Bags (WM 2.34), and respondents disagreed that the LGU had active recovery programs addressing chemical contamination specifically, with the lowest weighted mean in the entire survey (WM 1.76) recorded for LGU projects on floodwater contamination from industrial chemical releases. This pattern — strong flood literacy paired with weak Natech literacy — recurs across all five survey domains (prevention/mitigation, preparedness, response, and recovery) and is the single most important diagnostic finding in the situational analysis.

A. PESTEL Analysis

1) Political: RA 10121 mandates LGU-level DRRM structures, but Natech/HazMat integration into contingency plans remains underdeveloped.

2) Economic: Bauan's tax base and employment depend on petroleum, shipyard, and port industries, yet many households rely on informal or seasonal income, limiting household-level disaster preparedness spending — reflected in the low Go Bag ownership rate.

3) Social: A largely working-age population (73% aged 26–59) carries primary responsibility for response, while vulnerable groups (seniors, children, pregnant women, fisherfolk, low-income households) face disproportionate exposure; a stark awareness gap exists between flood knowledge and Natech knowledge.

4) Technological: Existing hazard maps and early-warning systems cover meteorological flooding, but no system yet monitors industrial containment integrity or chemical releases in real time.

5) Environmental: Climate-driven rainfall intensification increases the likelihood of floodwaters breaching industrial containment, degrading Batangas Bay's water quality, fisheries, and soil.

6) Legal: RA 10121, the Ecological Solid Waste Management Act (RA 9003), the Clean Water Act (RA 9275), and the Sendai Framework form the legal basis; formal adoption requires a Sangguniang Bayan resolution to give the plan binding force and budget allocation.

B. SWOC Analysis

1) Strengths: Existing contingency plans aligned with RA 10121; functional MDRRMO and Barangay DRRM Councils; use of hazard maps from agencies such as MGB; available DRRM funds; strong flood early-warning and evacuation systems.

2) Weaknesses: No dedicated Natech/HazMat policies or programs; inadequate HazMat PPE, decontamination facilities, and responder training; no Go Bag distribution; aging drainage systems not designed for present-day rainfall intensity; residential areas overlapping industrial zones.

3) Opportunities: Potential mutual-aid linkages between MDRRMO, BDRRMCs, BFP, and industrial stakeholders; co-

funding and equipment-sharing from industries; upgrading responder skills for HazMat incidents; adopting GIS-based multi-hazard modelling.

4) Challenges: Environmental degradation reducing natural flood buffers; industrial infrastructure built before recent rainfall intensification, leaving facilities flood-vulnerable; competing budget priorities.

III. GOALS AND OBJECTIVES

The action plan is organized around four thematic pillars; each anchored to a 2029 target goal and three objectives derived directly from the survey's identified weaknesses and challenges:

A. Prevention and Mitigation

1) Goal 1: Reduce industrial, environmental, and community vulnerabilities by improving risk reduction mechanisms against flood-induced industrial hazards in the Municipality of Bauan by 2029 (Weaknesses, Q4 Disaster Prevention and Mitigation)

Objectives:

1.1 Within a year, to improve industrial safety assessment and hazard identification mechanisms in all flood-prone and industrially exposed barangays. (Weaknesses, Q3 Disaster Prevention and Mitigation)

1.2 To enforce flood-resilient industrial compliance and environmental safety in identified industrial zones. (Challenges, Q5 Disaster Prevention and Mitigation)

1.3 To enhance environmental monitoring and flood mitigation systems in vulnerable communities. (Weaknesses, Q6 Disaster Prevention and Mitigation)

B. Disaster Preparedness

2) Goal 2: Strengthen institutional preparedness capacity and inter-agency coordination against flood-induced industrial hazards and environmental health emergencies by 2029 (Weaknesses, Q13 Disaster Preparedness)

Objectives:

2.1 To enhance the preparedness capacity of LGU offices, partner agencies, community members, and industrial stakeholders in handling flood-induced industrial emergencies within a year (Weaknesses)

2.2 To institutionalize emergency planning and simulation mechanisms for flood-induced HazMat-related health emergencies in all high-risk barangays and industrial areas (Weaknesses, Q8 Disaster Preparedness)

2.3 To improve emergency resource readiness and logistical preparedness of LGU offices and partner agencies for flood-induced industrial emergencies. (Weaknesses)

C. Disaster Response and Early Recovery

3) Goal 3: Institutionalize coordinated emergency response operations during flood-induced industrial hazard and related health emergencies in all identified industrial barangays by 2029 (Weaknesses)

Objectives:

3.1 To establish coordinated ICS-based emergency response mechanisms during flood-induced industrial hazards (Weaknesses)

3.2 To improve HazMat-related health emergencies response during flood-induced industrial and environmental contamination incidents (Weaknesses)

3.3 To enhance HazMat emergency response operations in all identified high-risk barangays (Weaknesses)

D. Disaster Rehabilitation and Recovery

4) Goal 4: Enhance environmental rehabilitation and recovery mechanisms following flood-induced industrial and public health emergencies by 2029 (Weaknesses, Q26, Disaster Recovery and Rehabilitation)

Objectives:

4.1 To conduct environmental cleanup and decontamination operations in flood-affected and industrially contaminated areas (Weaknesses)

4.2 To provide housing and shelter recovery assistance for all displaced populations (Weaknesses, Q24 in Disaster Recovery and Rehabilitation)

4.3 To improve post-disaster policy review, capacity enhancement, and resilience-building initiatives relative to flood-induced industrial hazards (Weaknesses, Q26 Disaster Recovery and Rehabilitation)

IV. ACTION PLAN

A. PPA Matrix: Prevention and Mitigation Goal 1 – Objective 1

1) Outcome: Reduced vulnerability of industrial facilities and nearby communities through strengthened hazard assessment, industrial monitoring, and environmental safety interventions

PPA's

1.1.1 Flood and industrial hazard mapping
1.1.2 Inventory of industrial facilities & hazardous materials
1.1.3 Assessment of chemical storage tanks and pipelines

Updating of hazard maps will be conducted from January to June 2027 and will cost around ₱250,000.00, which includes posting in critical areas and the barangay hall. An industrial hazard inventory database will be generated from the inventory of industrial facilities and hazardous materials to know exactly which facilities store hazardous chemicals in low-lying, flood-prone areas. The assessment of chemical storage tanks and pipelines in the industrial facilities near flood-prone areas shall generate

reports that are relevant in planning mitigation programs.

PPA Matrix: Prevention and Mitigation Goal 1 – Objective 2

2) Outcome: Improved flood-resilient industrial compliance and reduced risk of chemical contamination during flooding incidents

PPA's

1.2.1 Structural assessment of industrial drainage systems
1.2.2 Structural assessment of industrial facilities
1.2.3 Posting of Chemical Disclosure Reports and Inspection Reports

The PPA 1.2.1 addresses physical infrastructure by targeting industrial drainage networks. PPA 1.2.2 brings together industrial stakeholders to align local businesses with municipal disaster risk reduction strategies. PPA 1.2.3, ensures that residents know exactly what hazards (e.g., manufacturing acids, industrial gases) are being stored by commercial facilities within their jurisdiction.

PPA Matrix: Prevention and Mitigation Goal 1 – Objective 3

3) Outcome: Improved environmental safety and reduced contamination risks in flood-prone communities.

PPA's

1.3.1 Conduct coastal and river rehabilitation activities
1.3.2 Tree planting and slope protection activities
1.3.3 Public awareness campaign on flood-related contamination risks

The actions outlined in this matrix shift the focus from the industrial zones directly into the vulnerable communities of Bauan. Under Objective 1.3, these three interconnected activities aim to establish a buffer against flood-induced contamination through physical rehabilitation, nature-based solutions, and community-level education.

Key interventions include flood and industrial hazard mapping of all 40 barangays (₱250,000); an industrial hazard and hazardous-materials inventory database (₱150,000); structural assessment of chemical storage tanks, pipelines, and industrial drainage networks (₱350,000 and ₱200,000, respectively); annual structural assessment of industrial facilities and public posting of chemical disclosure and inspection reports (so residents know what is stored nearby); and environmental buffering measures — coastal and river rehabilitation (₱1,500,000), riverbank tree planting and slope protection (₱200,000), and semi-annual IEC campaigns reaching 2,000 residents on contamination risk (₱120,000).

B. PPA Matrix: Preparedness Goal 2 – Objective 1

1) Outcome: Improved institutional readiness and coordinated emergency preparedness mechanisms during flood-induced industrial and public health emergencies.

PPA's

2.1.1 Incident Command System (ICS) trainings
2.1.2 HazMat awareness and preparedness trainings
2.1.3 Develop industrial emergency response protocols

The activities outlined under Objective 2.1 mark a transition from structural prevention to institutional readiness. This suite of PPAs focuses entirely on upgrading the human resource capabilities, standardized operational frameworks, and inter-agency coordination required to handle highly complex, flood-induced chemical and public health risks.

PPA Matrix: Preparedness Goal 2 – Objective 2

2) Outcome: Enhanced operational preparedness and coordinated emergency response planning among responders and stakeholders

PPA's

2.2.1 Procure an industrial simulation system for flooded-HazMat Operations
2.2.2 Evacuation drills in industrial barangays
2.2.3 Develop evacuation and decontamination plans

The activities detailed under Objective 2.2 focuses on taking theoretical emergency protocols and operationalizing them through procurement of simulation systems, hands-on field drills, and community-specific escape frameworks. This set of PPAs shifts the strategy from classroom training to active field readiness for complex industrial and public health emergencies.

PPA Matrix: Preparedness Goal 2 – Objective 3

3) Outcome: Improved availability and accessibility of emergency resources and logistical support during disasters.

PPA's

2.3.1 Procure HazMat PPE and response equipment
2.3.2 Procure emergency medical supplies

2.3.3 Establish emergency supply stockpile

The activities under Objective 2.3 shift the focus from training and tactical planning to physical asset acquisition and logistical positioning. This suite of PPAs targets the concrete procurement of life-saving equipment, medical caches, and humanitarian relief, ensuring that emergency responders and high-risk communities are backed by tangible resources when a disaster strikes.

This pillar shifts from physical infrastructure to institutional and human capacity. Annual Incident Command System (ICS) training for LGU responders and barangay officials (₱250,000) builds a standardized command structure for crises. Semi-annual HazMat awareness training for responders and industrial stakeholders (₱180,000) and the 2027 development of approved industrial emergency response protocols (₱120,000) extend readiness into the private sector. The single largest preparedness investment is a ₱1,400,000 industrial HazMat simulation system, giving responders a realistic training environment without real-world chemical risk. This is paired with semi-annual evacuation drills in flood-prone barangays (₱150,000) and the 2027 development of barangay-level evacuation and decontamination plans (₱120,000), plus logistical readiness measures such as pre-positioned emergency supplies and equipment.

C. PPA Matrix: Response and Early Recovery Goal 3 – Objective 1

1) Outcome: Improved coordination, command, and operational response among responding agencies during emergencies.

PPA's

3.1.1 Activate Incident Command System during emergencies
3.1.2 Conduct emergency coordination meetings
3.1.3 Activate Emergency Operations Center (EOC)
3.1.4 Conduct inter-agency response mobilization

The PPA 3.1.1 activity represents the immediate rollout of tactical command on the ground. The second PPA 3.1.2 activity focuses on keeping communication channels fluid among response cluster members (e.g., health, logistics, security). While the ICS manages tactical operations directly at the disaster site, the EOC serves as the centralized, physical, or virtual hub that coordinates the big-picture logistics, resources, and communication channels for all LGU response agencies. PPA 3.1.4 represents the actual, physical deployment of specialized forces into the hazardous flood zones.

PPA Matrix: Response and Early Recovery Goal 3 – Objective 2

2) Outcome: Improved coordination, command, and operational response among responding agencies during emergencies.

PPA's

3.2.1 Conduct disease surveillance activities
3.2.2 Conduct distribution of hygiene kits
3.2.3 Conduct vaccination and medical consultation activities

The PPA 3.2.1 activity acts as an early warning system for public health. It targets evacuation centers and barangays to actively track and monitor signs of waterborne illnesses, skin infections, or chemical poisoning symptoms before they mutate into an unmanageable outbreak. The PPA 3.2.2 recognizes that poor sanitation in crowded shelters is the leading cause of post-disaster illness; this activity targets evacuees directly. Providing basic hygiene materials ensures individuals can maintain personal cleanliness, effectively breaking the transmission chain of waterborne and communicable diseases. The PPA 3.2.3 represents the active medical treatment and clinical defense pillar targeting vulnerable sectors (e.g., children, the elderly, or individuals directly exposed to contaminated floodwaters).

PPA Matrix: Response and Early Recovery Goal 3 – Objective 3

3) Outcome: Improved coordination, command, and operational response among responding agencies during emergencies.

PPA's

3.3.1 HazMat containment operations
3.3.2 Conduct emergency decontamination operations
3.3.3 Deploy HazMat response teams
3.3.4 Industrial hazard monitoring

The activities detailed under the Objective 3.3 outlines highly specialized, high-stakes operational interventions designed to take place strictly "during emergencies." This suite of PPAs focuses directly on

neutralizing toxic hazards, protecting human life from chemical exposure, and monitoring environmental contamination when floodwaters compromise industrial containment networks. It outlines immediate, specialized field interventions deployed during emergencies to directly contain industrial chemical spills and safely decontaminate affected individuals. Additionally, it ensures active environmental monitoring and the deployment of expert tactical teams to minimize public and responder exposure to toxic hazards amidst severe flooding.

Response PPAs are activated specifically "during emergencies" and combine an Incident Command System for multi-agency coordination with two parallel response tracks. The public-health track includes disease surveillance at evacuation centers (₱150,000, Municipal Health Office), hygiene-kit distribution to evacuees (₱250,000, DSWD/MHO) to interrupt disease transmission in crowded shelters, and vaccination and medical consultation for vulnerable groups (₱300,000, MHO). The HazMat track — the largest response expenditure category — includes chemical containment operations at spill sites (₱500,000, BFP/MENRO), decontamination corridors for exposed responders and residents (₱250,000, BFP/MHO), rapid deployment of specialized HazMat teams to high-risk industrial areas (₱300,000, BFP/MDRRMO), and continuous industrial hazard monitoring of water quality and chemical plumes to feed real-time alerts to the Emergency Operations Center (₱120,000, MENRO).

D. PPA Matrix: Rehabilitation and Recovery Goal 4 – Objective 1

*1) **Outcome:*** Reduced environmental contamination and restored environmental safety in affected communities.

PPA's

4.1.1 Environmental cleanup operations
4.1.2 Decontamination operations in affected communities
4.1.3 Conduct rehabilitation of contaminated waterways

The final phase of the disaster risk reduction and management cycle transitions into long-term restoration. Operating under Objective 4.1, this suite of PPAs shifts from active crisis management to the post-disaster phase, triggering specialized operations "after emergencies" and stretching into 2027–2028. The collective goal is to erase the lingering toxic footprint left behind by industrial flooding and restore environmental safety to contaminated ecosystems.

PPA Matrix: Rehabilitation and Recovery Goal 4 – Objective 2

*2) **Outcome:*** Improved shelter recovery and safer living conditions for displaced families.

PPA's

4.2.1 Conduct housing damage assessment
4.2.2 Emergency shelter assistance
4.2.3 Repair assistance for partially damaged houses

The activities under Objective 4.2 focus on the human element of post-disaster recovery, specifically, transitioning displaced families from temporary evacuation centers back into secure, stable environments. Executed primarily "after emergencies" and extending through 2027–2028, this suite of PPAs outlines a clear, step-by-step logistical framework to evaluate home destruction, provide immediate relief, and fund the physical reconstruction of residential areas.

PPA Matrix: Rehabilitation and Recovery Goal 4 – Objective 3

*3) **Outcome:*** Enhanced institutional learning and strengthened disaster resilience mechanisms after emergencies.

PPA's

4.3.1 Post-disaster evaluation and after-action reviews
4.3.2 Review and updating of DRRM plans
4.3.3 Policy review workshops
4.3.4 Resilience-building capacity development programs

The activities represent the institutional closing of the disaster management loop. By reviewing past performance and updating regulatory frameworks, the municipality ensures that the lessons learned from flood-induced industrial crises are institutionalized to build long-term community resilience.

Recovery PPAs address both environmental and human dimensions of post-disaster restoration: environmental cleanup and rehabilitation of contaminated waterways (up to ₱1,500,000); housing damage assessment (₱180,000), emergency

shelter assistance (₱800,000), and repair assistance for partially damaged homes (₱2,000,000, coordinated with the NHA); and institutional learning activities — post-disaster after-action reviews (₱150,000), periodic review and updating of DRRM plans (₱180,000), Sangguniang Bayan policy review workshops (₱100,000), and resilience-building capacity development programs (₱250,000).

Funding across all four pillars is sourced primarily from the Local and Barangay Disaster Risk Reduction and Management Funds (LDRRMF/BDRRMF), the General Fund, and the 20% Development Fund, with selected projects co-funded by DENR and the prospect of industrial-stakeholder contributions.

V. MONITORING AND EVALUATION

Each PPA carries its own monitoring and evaluation matrix tracking performance indicators, accomplishment targets, responsible offices, and reporting frequency, ensuring accountability across all four goals and twelve objectives. Periodic post-disaster after-action reviews and scheduled review of DRRM plans and local ordinances are built into the plan to allow continuous improvement, in line with RA 10121 and the Sendai Framework's emphasis on adaptive, evidence-based disaster governance.

For operationalization, the plan assumes formal adoption through a Sangguniang Bayan resolution and inclusion in Bauan's Local Disaster Risk Reduction and Management Plan (LDRRMP) and Annual Investment Plan, giving it binding legal force, dedicated budget lines, and clear institutional accountability across the MDRRMO, MENRO, Engineering Office, Bureau of Fire Protection, Municipal Health Office, and barangay councils. The plan also envisions co-funding arrangements with industrial stakeholders, consistent with the SWOC analysis's identification of public-private collaboration as a key opportunity for closing Bauan's HazMat resource gap.

VI. CONCLUSIONS

The study concludes that the Municipality of Bauan, Batangas is highly vulnerable to the cascading effects of flooding and flood-induced industrial hazards, particularly in the barangays of Sta. Maria, San Roque, and San Miguel where residential communities and industrial establishments spatially overlap. While the municipality has existing capacities in flood preparedness, early warning, evacuation awareness, and general disaster response, these strengths are not sufficient to address the more complex risks associated with Natural Hazard Triggering Technological Disasters (Natech), including hazardous chemical release, toxic runoff, environmental contamination, and related public health emergencies.

The findings revealed that community knowledge and local programs are stronger in relation to flooding as a natural hazard, but remain limited in terms of awareness of industrial chemical risks, emergency actions during chemical spill incidents, and contamination-related health threats. The absence of integrated plans for HazMat incidents, inadequate specialized equipment, insufficient emergency medical and decontamination preparedness, and the lack of updated DRRM mechanisms specific to industrial flooding further increase the municipality's vulnerability. In addition, recovery and rehabilitation interventions remain more focused on conventional flood impacts and are not yet fully responsive to environmental contamination and industrial emergency consequences.

The study further established that an integrated, multi-sectoral, and evidence-based DRRM action plan is necessary to address the interconnected risks of flooding, industrial hazards, and public health emergencies. Through the proposed action plan, the municipality is provided with a strategic framework that strengthens institutional coordination, enhances technical and operational capacity, improves community awareness, and promotes long-term resilience. Integrating flood-induced industrial hazards into local DRRM planning, land use regulation, emergency preparedness, and recovery systems is therefore essential to building a safer, healthier, and more disaster-resilient Municipality of Bauan.

VII. RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations are proposed:

1. Integrate flood-induced industrial hazards and public health risks into the Local Disaster Risk Reduction and Management Plan (LDRRMP), contingency plans, and other local development and emergency planning instruments to ensure that Natech risks are formally recognized and addressed.
2. Require industrial establishments in flood-prone barangays to submit and regularly update chemical disclosure reports, industrial emergency response protocols, and flood contingency plans to strengthen transparency, risk governance, and coordinated preparedness.
3. Strengthen land use and zoning regulations by reviewing the Comprehensive Land Use Plan (CLUP), establishing appropriate buffer zones between industrial and residential areas, and restricting future industrial expansion in highly flood-prone locations.
4. Enhance HazMat preparedness and response capacity through the procurement of specialized personal protective equipment, decontamination tools, chemical monitoring devices, emergency medical supplies, and simulation systems for flood-induced industrial emergencies.
5. Conduct regular training, drills, and simulation exercises for MDRRMO, BFP, health personnel, barangay officials, industrial stakeholders, and community members to improve institutional readiness and coordinated emergency response.
6. Develop and institutionalize integrated evacuation and decontamination plans in all identified high-risk barangays to ensure safe movement, chemical exposure control, and protection of affected populations during emergencies.
7. Expand public awareness and risk communication campaigns on flood-related contamination, industrial hazard exposure, and health protection measures through seminars, IEC materials, and community-based education activities.
8. Establish systematic disease surveillance, environmental monitoring, and emergency reporting mechanisms during and after flood events to allow early detection of contamination, illness outbreaks, and chemical exposure incidents.
9. Strengthen recovery and rehabilitation programs by including environmental cleanup, waterway rehabilitation, shelter recovery assistance, and long-term resilience-building initiatives in post-disaster planning.
10. Promote sustained inter-agency and multi-stakeholder collaboration among the LGU, MDRRMO, BFP, MHO, MENRO, barangay councils, national agencies, and industrial operators to ensure a unified and effective approach to flood-induced industrial hazards and public health emergencies.

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