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Publication Frequency: Quarterly

The Environmental and Urban Planning International Journal (EUPIJ) is published quarterly, meaning four issues are released each year. This schedule allows for regular sharing of research findings and developments, while providing enough time for peer review and editorial work. By publishing quarterly, the journal ensures a balance between timely updates and high-quality content.

Each issue covers a range of topics, offering valuable research that is both relevant and impactful. The quarterly schedule also gives authors time to improve their work based on feedback, maintaining the journal's credibility and integrity. This process helps ensure that the journal remains a trusted source of knowledge in the field of environmental and urban planning. Additionally, it provides opportunities for collaboration and engagement among researchers, fostering a dynamic academic community.

The regular publication cycle also facilitates the inclusion of emerging topics and timely issues that are critical for both academic study and real-world application. It keeps the academic community informed on the latest trends, challenges, and innovations in environmental and urban planning, while supporting ongoing scholarly growth. Furthermore, the journal's consistent publishing schedule encourages authors to contribute regularly, creating a stable flow of research that continues to shape the discourse in the field.

Overall, this publication approach helps the EUPIJ maintain its position as a leading journal in environmental and urban planning, contributing to the advancement of knowledge, policy development, and practical solutions for sustainable urban development. The journal’s ongoing commitment to high standards ensures its relevance and utility for academics, practitioners, and policymakers alike.

ABOUT THE PUBLISHER

The Environmental and Urban Planning International Journal (EUPIJ) reflects the institution's commitment to fostering environmental and urban planning disciplinary research and facilitating academic exchange. As a respected publication, it provides a platform for scholars, researchers, and professionals from various fields to share their findings, insights, and innovations. Published by Zas Digital Institute Training and Development Services (DITADS), the journal focuses on the dissemination of high-quality research spanning a specific array of disciplines, including but not limited to environmental sciences, natural sciences, aquatic sciences, and other related fields.

The journal serves as a vital resource for advancing knowledge and facilitating dialogue among researchers, practitioners, and policymakers. By embracing interdisciplinary research, EUPIJ aims to address the complex issues of today's global society. It seeks to provide well-rounded solutions and perspectives by integrating ideas from various sectors of knowledge, enabling more holistic approaches to solving contemporary challenges.

Through its rigorous peer-blind review process and commitment to academic excellence, the Environmental and Urban Planning International Journal aims to contribute significantly to the global research community. The journal offers valuable insights into contemporary challenges and solutions, pushing the boundaries of academic inquiry in its focus areas. By providing a forum for the exchange of diverse ideas and research, it continues to promote innovation, foster intellectual growth, and inspire new thinking across disciplines.

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RATIONALE

The Environmental and Urban Planning International Journal (EUPIJ) was established to serve as a dynamic platform for the exchange of knowledge and ideas from the fields of environmental and urban planning. With the growing need for research in environmental and urban planning that addresses complex global challenges, this journal aims to foster collaboration among scholars, researchers, and professionals from diverse academic backgrounds. By providing a space for high-quality research in fields such as environmental sciences, natural sciences, aquatic sciences, technology, and urban development, EUPIJ contributes to the development of solutions that are both innovative and comprehensive.

The journal's primary goal is to enhance academic discourse and promote the dissemination of cutting-edge research, offering valuable insights that can inform policy, improve practices, and inspire future studies. By covering a wide range of topics, from urban planning development to environmental issues, the journal reflects the diverse and interconnected nature of today's environmental and sustainability landscape. Its intra- and interdisciplinary approach allows for the examination of issues from different angles, helping to create more robust and holistic solutions that address urgent global challenges, such as climate change, urbanization, and resource management.

EUPIJ also plays a crucial role in advancing the academic community by providing a platform for emerging voices and encouraging scholarly engagement across borders. Through its rigorous peer-blind review process, the journal ensures that only well-researched, impactful, and scientifically rigorous articles are published, maintaining its academic integrity and reputation. This process not only supports researchers but also engages a broader audience, including policymakers and practitioners, by bridging the gap between academic research and real-world application. It also allows the journal to maintain a diverse pool of contributors, ensuring that the content is reflective of a global and multi-perspective view on environmental and urban planning issues.

In line with the vision of Zas Digital Institute Training and Development Services (DITADS), EUPIJ aims to contribute significantly to both local and global research communities. It is committed to promoting academic excellence and fostering a deeper understanding of contemporary issues that affect societies worldwide. As part of its mission, the journal encourages collaboration between academic institutions, government bodies, private sectors, and non-governmental organizations, ensuring a comprehensive and inclusive approach to solving environmental and urban planning challenges.

This journal represents a vital tool for the ongoing development of knowledge and innovation, making it an indispensable resource for researchers, academics, and professionals who are committed to making a positive impact on society. EUPIJ is not only an academic publication but a catalyst for action, driving change through research that empowers communities and fosters sustainable development across the globe.

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The Effect of Installed Trash Traps within the Province of Cavite Under the MBRP for Years 2021-2023: A Baseline Study

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ABSTRACT

The uncontrolled generation of solid waste that drains through the waterways of the Province of Cavite into Manila Bay poses a serious environmental threat to the bay's natural environment and biodiversity. In response to the Supreme Court's Writ of Continuing Mandamus under G.R. No. 171947-48, the Department of Environment and Natural Resources – Provincial Environment and Natural Resources Office (DENR–PENRO) Cavite, through the Manila Bay Site Coordinating/Management Office (MBSCMO) Cavite, installed 49 trash traps strategically positioned along the six major river systems of the province as part of the Manila Bay Rehabilitation Program (MBRP). This baseline study employed a mixed-methods research design using the nested (embedded) approach, with data analyzed through the percentage method. Monitoring was conducted over three years (2021–2023). Results revealed that, on average, 66% of installed units were functional while 34% were non-functional across the monitoring period. Despite this, the installed units collectively captured a total of 2,037,227 kilograms (approximately 2,005.1 metric tons) of mixed solid wastes. Waste collection increased by 72% from 2021 to 2022 (669,091 kg to 928,754 kg), partly attributed to COVID-19-related healthcare waste. A notable decrease of -211% was recorded in 2023 (as of the 3rd quarter), reflecting positive outcomes from intensified Communication, Education and Public Awareness (CEPA) campaigns, establishment of barangay ecological gardens, and other solid waste management interventions. The study concludes that trash traps are effective solid waste interception mechanisms and recommends their turnover to respective Local Government Units (LGUs) through a Memorandum of Agreement (MOA) and the replication of the project in applicable waterways.

Keywords: *Trash Traps, Manila Bay Rehabilitation Program, Solid Waste Management, DENR–PENRO Cavite, Waterway Pollution, River Rangers, MBRP, Environmental Baseline Study*

BACKGROUND OF THE STUDY

A. History of the Department of Environment and Natural Resources (DENR)

The history of DENR started during the Spanish colonization in the Philippines. It was in 1863 when the *Inspección General de Montes* in the Philippines was created by virtue of a Spanish Royal Decree with functions and responsibilities that included several concerns related to the management of a wide range of natural resources, such as forest inventory and protection, water, biodiversity, and mineral resources conservation. The *Departamento de Formento,* or the Department of Public Welfare, was established in 1898 by a decree signed by Gen. Emilio Aguinaldo, where one of its divisions was the Industry and Agricultural Division, and one of its sections was the Mines and Mountains Section.

The Americans came and reorganized the government, resulting in the creation of the Department of the Interior in 1901, which was vested with powers and authority on matters that included natural resources. In 1916, the Philippine Government issued Act No. 2666, "An Act to Reorganize the Executive Department of the Government of the Philippine Islands", transferring the functions and authority regarding agriculture and natural resources from the Department of Interior to the Department of Agriculture and Natural Resources

(DANR). The bureaus under its supervision include Agriculture, Forestry, Lands, Science, and Water.

The shift to the parliamentary form of government led to the renaming of the DNR to the Ministry of Natural Resources (MNR) in 1978. Subsequently, Executive Order (EO) No. 131 was issued on January 30, 1987, creating the Department of Energy, Environment, and Natural Resources (DEENR), taking the powers and functions of the MNR. It also incorporated the emerging critical concerns about energy and the environment. However, the said EO was not implemented. Thereafter, the government issued EO No. 192 on June 10, 1987, reorganizing the DEENR and renaming it as the Department of Environment and Natural Resources (DENR) while transferring energy matters to the Office of the President. The bureaucracy is decentralized with the transformation of former line bureaus to staff bureaus, and most of the line functions are transferred to the regional and field offices. The sectoral staff bureaus of the DENR are as follows:

a. Forest Management Bureau (FMB)–integrating and absorbing most of the powers and functions of the Bureau of Forest Development and the Wood Industry Development Authority.
b. The Land Management Bureau (LMB) is the central office of the Bureau of Lands, integrating the district land offices with the DENR field offices.
c. Mines and Geosciences Bureau (MGB)–absorbing the functions of the Bureau of Mines and Geosciences.
d. Environmental Management Bureau (EMB)–integrating the National Environmental Protection Council (NEPC), National Pollution Control Commission (NPCC), and the Environmental Center of the Philippines (ECP).
e. Ecosystems Research and Development Bureau (ERDB) is a merger of the former Forest Research Institute and the National Mangrove Committee.
f. Protected Areas and Wildlife Bureau (PAWB)

The enactment of RA 7942, otherwise known as the Philippine Mining Act, in 1995 restored the line functions of the MGB and provided for the creation of its regional offices nationwide.

Similarly, the enactment of RA 8749, otherwise known as the Philippine Clean Air Act, transformed the EMB from a staff bureau to a line bureau and mandated it to be the lead agency in the overall implementation of the law's provisions. Likewise, the Pasig River Rehabilitation Commission (PRRC) was created by virtue of EO 54 and attached to the DENR in the same year through EO 65.

On October 18, 2013, the Department of Budget and Management (DBM) approved the DENR Rationalization Plan (RatPlan). Through the said RatPlan, the DENR was able to focus on the vital and core functions of the agency, improve the quality and efficiency of services by eliminating overlaps and duplications of functions, and promote efficient and result-oriented performance and accountability. The PAWB was also renamed as the Biodiversity Management Bureau (BMB) to represent the expanding responsibilities beyond protected areas.

B. DENR Mandate, Vision, and Mission DENR Mandate (EO 192, s. 1997)

The Department is the primary government agency responsible for the conservation, management, development, and proper use of the country's environment and natural resources, specifically forest and grazing lands, mineral resources, including those in reservations and watershed areas, and lands of the public domain, as well as the licensing and regulation of all natural resources, as may be provided for by law, for equitable sharing of the benefits derived therefrom for the welfare of the present and future generations of Filipinos.

To accomplish this mandate, the Department shall be guided by the following objectives, to wit:

a. Assure the availability and sustainability of the country's natural resources through judicious use and systematic restoration or replacement, whenever possible;
b. Increase the productivity of natural resources in order to meet the demands for forest, mineral, and land resources of a growing population;
c. Enhance the contribution of natural resources for achieving national economic and social development;
d. Promote equitable access to natural resources by the different sectors of the population; and,
e. Conserve specific terrestrial and marine areas representative of the Philippine natural and cultural heritage for present and future generations.

DENR Vision. A nation enjoying and sustaining its natural resources and a clean and healthy environment.

DENR Mission. To mobilize our citizenry in protecting, conserving, and managing the

environment and natural resources for the present and future generations.

Development Goal. Human well-being, environmental quality, and sustainability are ensured.

Organizational Outcomes

- Promote human well-being and ensure environmental quality
- Sustainably-managed environment and natural resources
- Adaptive capacities of human communities and natural systems ensured

DENR Five (5)-point Agenda. The DENR thrust and priorities are anchored on a five (5)-point agenda, to wit:

1. Poverty reduction and hunger mitigation
2. Socio-economic development
3. Natural resources conservation
4. Climate change mitigation and adaptation measures
5. Environmental education and enforcement

DENR Ten (10) Priority Programs. The Ten (10) Priority Programs of the agency are as follows:

1. Clean Air
2. Clean Water
3. Solid Waste Management
4. Geo-hazard, Groundwater Assessment, and Responsible Mining
5. Forest and Watershed Management
6. Intensified Forest Protection and Anti-illegal Logging
7. Enhanced Biodiversity Conservation
8. Scaling up of Coastal and Marine Ecosystem
9. Improved Land Administration and Management
10. Manila Bay Clean-up

Similarly, the different development frameworks such as Sustainable Development Goals under the United Nations, Philippine Long-Term Vision–Ambisyon Natin 2040, Philippine Development Plan 2017-2022, and the Program for Environment and Natural Resources for Restoration, Rehabilitation and Development (PRRD) are bases of aforementioned programs implementation towards "*MATATAG, MAGINHAWA AT PANATAG NA BUHAY*."

C. Organizational Structure

The Department is headed by the Secretary and is being assisted by nine (9) Undersecretaries and eight (8) Assistant Secretaries. Under them are four (4) staff bureaus (FMB, LMB, BMB, and ERDB), two (2) line bureaus (EMB and MGB), 16 Regional Environment and Natural Resources Offices, 76 Provincial Environment and Natural Resources Offices (PENROs), and 143 Community Environment and Natural Resources Office (CENROs).

D. DENR CALABARZON and its Organizational Structure

DENR Region IV–A, also known as the CALABARZON Region, was created on May 17, 2002, by virtue of EO 103. It is located in the southwestern part of Luzon, just south and east of Metro Manila, on the east by the Philippine Sea and Bicol Region, on the south by Verde Island Passage, and on the west by Luzon Sea. It is practically accessible via all types of land transportation.

The DENR CALABARZON Region is headed by the Regional Executive Director, with five (5) PENROs and seven (7) CENROs.

E. PENRO Cavite Profile and its Organizational Structure

The Provincial Environment and Natural Resources Office (PENRO) plans, coordinates, controls, prepares and updates plans for the protection of the environment, development and conservation of natural resources in the provinces; enforces environment and natural resources laws, rules and regulations; and performs such functions that may be assigned by higher authority.

The two (2) divisions at the PENRO Cavite Level are as follows:

a. Technical Services Division – coordinates and supervises the implementation of all policies, regulations, programs and projects on environmental and natural resources conservation in the province; supervises the provision of technical services to the CENROs within its jurisdiction; represents the province in the provincial development bodies in the formulation and implementation of provincial plans and programs; and performs such functions that may be assigned by higher authority. It is composed of three (3) sections, namely the Conservation and Development Section, the Regulation and Permitting Section, and the Monitoring and Enforcement Section.

b. Management Services Division – oversees the delivery of financial and administrative services within its jurisdiction; ensures that all

administrative and financial transactions are in compliance with COA, DBM and CSC rules and regulations; ascertains that plans and programs are attained through sufficient and timely release of funds; monitors spending vis-a-vis accomplishments for efficient and economic fund utilization within its jurisdiction; provides assistance and services on the implementation of office orders, rules and regulations on matters involving personnel management, general services, communications, logistics, property, safety, records management and documentation; and performs other functions that may be assigned by higher authority. It shall be composed of two (2) sections, namely the Planning and Management Section and the Administrative and Finance Section.

However, PENRO Cavite is an implementing PENRO or one of those PENROs without CENRO(s), which perform the roles and functions of a CENRO. Hence, in addition to its supervisory function, the said Office is also responsible for the implementation of all laws, policies, regulations, programs, and projects, rules and regulations on the management, conservation, development, and use of natural resources.

F. The Manila Bay Rehabilitation Program (MBRP) and the Manila Bay Region

On December 18, 2008, the Supreme Court issued a decision under G.R. No. 171947-48 ordering the 13 Mandamus Agencies to clean up, rehabilitate, and preserve Manila Bay in their own capacities. Moreover, the water quality of the Manila Bay should be restored to Class B Sea Waters, which are fit for swimming, skin-diving, and other forms of contact recreation as per the Water Classification Table under the DENR Administrative Order No. 34 s. 1990.

The DENR, as the lead agency, together with the 13 Mandamus Agencies namely DENR, Department of Interior and Local Government (DILG), Department of Education (DepEd), Department of Health (DOH), Department of Agriculture (DA), Department of Public Works and Highways (DPWH), DBM, Philippine Coast Guard (PCG), Philippine National Police-Maritime Group (PNP-MG), Philippine Port Authority (PPA), Metropolitan Manila Development Authority (MMDA), Metropolitan Waterworks and Sewerage System (MWSS), and Local Water Utilities Administration (LWUA) are mandated to implement the Operational Plan for the Manila Bay Coastal Strategy (OPMBCS) which focuses on five (5) areas of concerns such as liquid waste management, solid waste management, informal settlers, habitat and resource management and institutional arrangement/partnership governance. The integration of land use governance frameworks and smart technologies into environmental planning efforts remains a critical complement to programmatic interventions such as the MBRP, particularly in ensuring that rehabilitation outcomes are sustainable and institutionally anchored (Santiago, 2025a).

The said decision was further strengthened by virtue of a Supreme Court En Banc resolution dated February 11, 2011, through the creation of the Manila Bay Coordinating Office (MBCO) under the DENR Administrative Order No. 2011-01. The MBCO was directed to fully implement the OPMBCS in coordination with the mandamus and other cooperating agencies. Likewise, the DAO designated the DENR Regional Executive Directors (RED) of Regions III, CALABARZON, and National Capital Region (NCR), who have jurisdiction over the Manila Bay, as Regional Coordinators and Heads of their own reconstituted Manila Bay Site Coordinating/Management Office (MBSCMO).

On February 19, 2019, President Rodrigo R. Duterte issued Administrative Order No. 16, "Expediting the Rehabilitation and Restoration of the Coastal and Marine Ecosystem of the Manila Bay and Creating the Manila Bay Task Force". The Task Force members shall perform their functions in accordance with their agency mandates and as prescribed in the Writ of Continuing Mandamus.

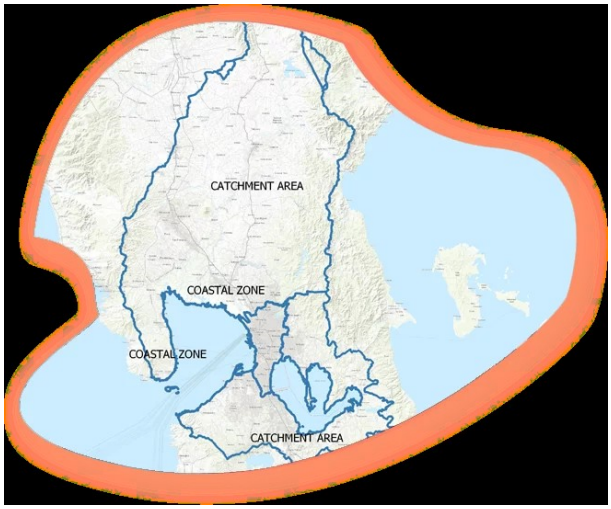
The Phases of Manila Bay Rehabilitation are as follows, to wit:

a. Phase 1 – Clean-up/Water Quality Improvement
b. Phase 2 – Rehabilitation and Resettlement
c. Phase 3 – Education and Sustainment

Aside from being a historical symbol for the Filipino people, Manila Bay is a marine gem that unceasingly makes a significant economic contribution to the country. It is located in the southwest portion of Luzon, facing the West Philippine Sea. Its surface area measures around 199 square kilometers (199,400 hectares), covering eight (8) provinces, 178 Local Government Units (LGUs), and 5,714 barangays in Regions III (Central Luzon), CALABARZON, and NCR (see Figure 1). The Bay has a 190-kilometer stretch of coastline, with at least 17 major river systems in the three regions draining into it.

G. The Manila Bay Site Coordinating/Management Office (MBSCMO) Cavite and its Organizational Structure

The DENR – PENRO Cavite thru the MBSCMO Cavite is implementing the MBRP to clean-up and rehabilitate the six (6) major river systems in the province namely Zapote, Imus, Ylang-Ylang-Rio Grande, Canas, Labac and Maragondon, to include coastal areas, waterways and canals/esteros within the Province of Cavite that are draining directly to Manila Bay (see Figure 2).



Source: Manila Bay Coordinating Office (manilabayanihan.com)

Figure 1. The Manila Bay Region.

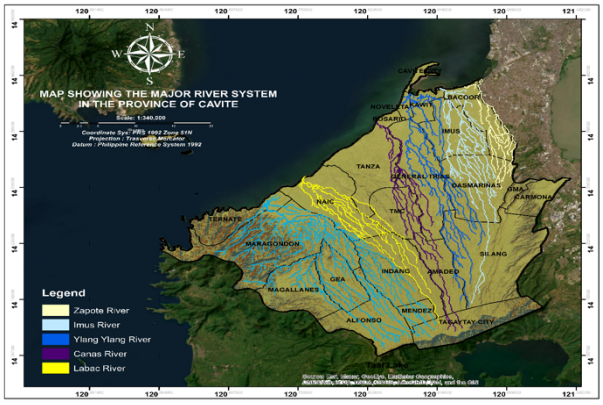


Figure 2. The Six (6) Major River Systems in the Province of Cavite.

The following are the five (5) target outcomes per cluster of the OPMBCS that are being interpreted into different activities of the MBSCMO Cavite to be able to appreciate the correlation of establishing an activity to one another in achieving the goal of cleaning up, rehabilitating, and preserving the Manila Bay, to wit:

a. Liquid Waste Management–The liquid wastes discharging into Manila Bay are compliant with the General Effluent Standard (GES) and/or the ambient water quality with the water quality guidelines.
b. Solid Waste Management–The amount of solid waste ending up in Manila Bay is reduced.
c. Informal Settler Families (ISFs) and Illegal Structures – Houses, structures, constructions, and other encroachments along easement areas in rivers/waterways, esteros, lakes, bays, and coastlines within the Manila Bay Region are permanently removed.
d. Habitat and Resource Management–The existing biodiversity within the Manila Bay Region is safeguarded and preserved, and soil loss in the bay is reduced.
e. Institutional Arrangement/ Partnership and Governance–The OPMBCS is properly implemented, entrusting the Mandamus Agencies and the MBSCMO to collaborate/converge in order to achieve its Key Performance Indicators (KPI).

Relative to the aforesaid five (5) target outcomes of the OPMBCS, various interventions are being undertaken by the MBSCMO Cavite in order to clean up, rehabilitate, and preserve Manila Bay, such as but not limited to the following:

a. installation of Aquatic Macrophyte Biosorption System (AMBS)
b. installation of a biogas digester
c. clean-up activities/solid waste collection through River Rangers, trash traps/trash nets, and donated trash boats
d. fabrication and installation of trash traps/trash nets
e. establishment of barangay ecological gardens and establishment of composting facilities
f. ground delineation of easement area and inventory of Informal Settler Families (ISFs)
g. hiring of River Rangers (RRs)

With all these interventions, improper solid waste management in the Province of Cavite can still be observed. This dilemma can be very alarming because mixed solid wastes are found in some of the rivers/waterways/canals that drain into Manila Bay. In addition to this, Cavite has no sanitary landfill (SLF) that will cater to all the generated solid wastes of the province. Thus, in view of the goal to reduce solid wastes ending up in Manila Bay, there are forty-nine (49) installed trash traps within the Province of Cavite (see Figure 3). It is an intervention under the Solid Waste Management Cluster of the MBRP that aids in the screening of solid waste along waterways and makes their collection easier.

The former DENR Secretary Roy A. Cimutu called this endeavor the "Battle for Manila Bay" and he added that "This is one battle that will be won not with force or arms, but with the firm resolve to bring Manila Bay back to life." Consequently, the MBSCMO Cavite is composed of committed and determined individuals/employees who are willing to do his/her share in these rehabilitation efforts, and is headed by a Focal Person.

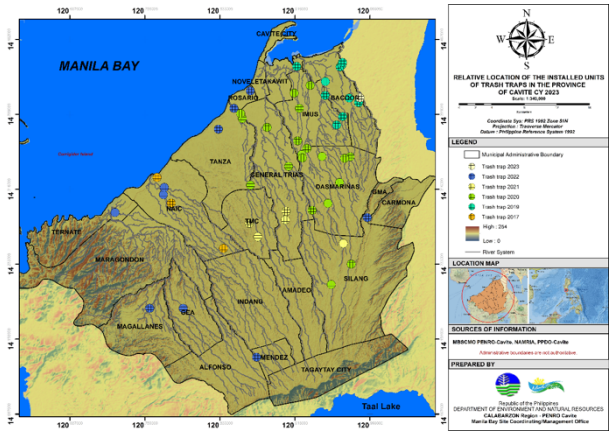


Figure 3. The 49 Installed Trash Traps within the Province of Cavite.

STATEMENT OF THE PROBLEM

The uncontrolled solid waste generation ending up in the waterways of the Province of Cavite, draining into Manila Bay, is a serious environmental problem that threatens the natural environment as well as the biodiversity in the Manila Bay Region.

MATERIALS AND METHODS

Research methodology refers to specific procedures for collecting and analyzing data that guarantee substantial and reliable findings that address the research problem.

In this study, the researchers used mixed-method research. It is a research approach where researchers collect and analyze both qualitative and quantitative data within the same study (see Figure 4). It draws on potential strengths of both qualitative and quantitative methods, which allow researchers to explore diverse perspectives. Moreover, this approach supports the articulation of different techniques to deepen the study of a given phenomenon in a broader and deeper perspective, in order to obtain richer and more varied data that might be drawn from several approaches or paradigms.

Source: Mixed Methods Research ~ Different Types & Examples (bachelorprint.com)
Figure 4. The Mixed Method Research.

Due to time restrictions and/or scarce resources, the researchers adopted the nested research design of the Mixed Method Research. This approach is also known as the embedded method where both qualitative and quantitative data are collected concurrently. However, one type of data takes precedence over the other.

To further analyze and process the collected data, the researcher used the Percentage Approach, the most commonly used statistics. It is a relative value indicating hundredth parts of any quantity. Besides being especially useful when making comparisons, they come in handy for studying a difference compared with a benchmark or initial value. Figure 5 shows the Percentage Formula as follows:

$$\text{Value 1 as a percentage of Value 2} = \frac{\text{Value 1}}{\text{Value 2}} \times 100\%$$

Source: Percentages Concepts and Definitions (mom.gov.sg)
Figure 5. The Percentage Formula.

RESULTS AND DISCUSSION

The Installed Trash Traps within the Province of Cavite

One of the identified serious environmental problems that threatens the natural environment as well as the biodiversity in the Manila Bay Region is the uncontrolled solid waste generation, ending up in the waterways of the Province of Cavite. As a response, one of the strategies/interventions undertaken by the MBSCMO Cavite is the installation of trash traps in strategic locations within the waterways of the province. The installed units will be able to trap/screen the solid wastes before reaching the Manila Bay. Hence, it will improve the waste collection and proper disposal which help reduce flooding during the rainy season.

Prior to installation, coordination meetings between the concerned LGU and the MBSCMO Technical Personnel will be conducted in order to identify possible locations where trash trap is deemed necessary. Nevertheless, trash traps are only applicable in river/tributary/waterbody with a width

of 20 meters and below. Once the LGU has approved the location, PENRO Cavite will facilitate the procurement process and the trash trap design to be used is drawn/designed by the licensed Civil Engineer of the MBSCMO 4 – CALABARZON. The participatory dimension of this coordination process reflects broader principles of community engagement in environmental planning, wherein inclusive stakeholder consultation strengthens the acceptance, maintenance, and long-term effectiveness of infrastructure interventions (Santiago, 2025b).

In 2017, the first batch of trash traps composed of three (3) units were installed in the Municipality of Naic, Cavite. These are gate-typed where the stream force is used to push the trash into the trash trap wings and once the trap can no longer accommodate the load of the trapped garbage, the wheel will be manually released to open the gate in order to avoid damages on the unit (see Figure 6 and 7).

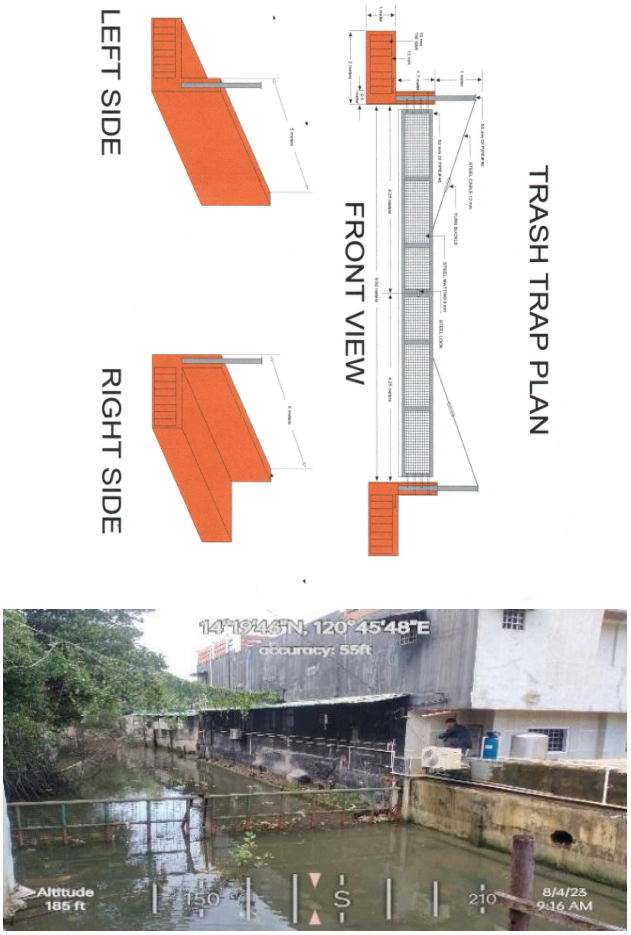
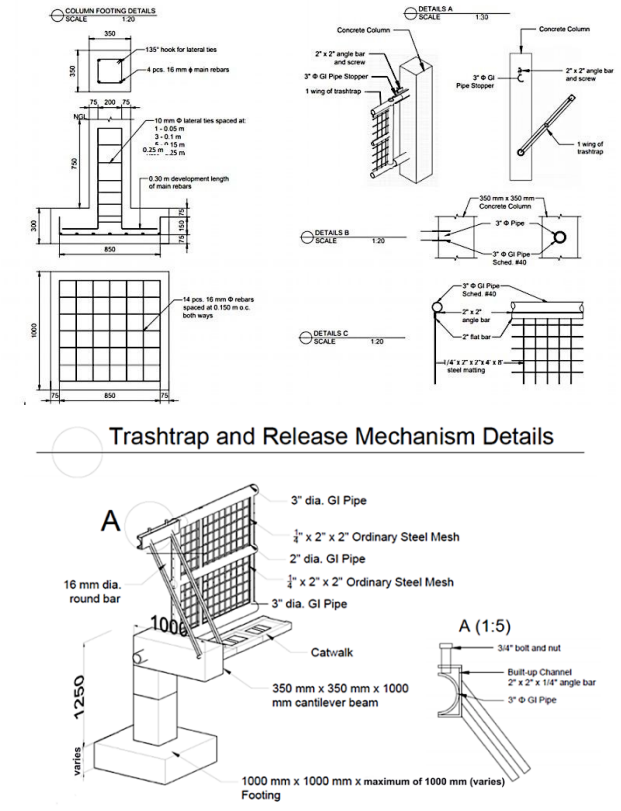


Figure 6 and 7. The (a) Design and (b) Actual photo of the Gate-typed Trash Trap installed in Brgy. Bucana Sasahan, Naic, Cavite.

The second batch of trash traps composed of 10 units were installed in 2019 in the Municipality of Kawit and the Cities of Bacoor and Imus, Cavite. Over the years, it has been observed that although effective, clogging and/or passing through of solid wastes within the trash trap wings were inevitable due to manual mechanism. Thus, observations and experiences relative to trash trap installation resulted in the improvement of its effectiveness thru modifications in the design.

The pandemic in 2020 has not been a hindrance to the implementation of the MBRP, thus, 20 trash traps with improved design were installed in the Municipalities of Silang and Tanza, and the Cities of Imus, Gen. Trias and Dasmariñas, Cavite. These are collapsible-typed where the stream force is used to push the garbage into the trash trap wings and once the trap can no longer accommodate the load of the trapped garbage, the wheel will then be mechanically released causing the trap wings to collapse and retain the garbage in the trap. This mechanism suppressed clogging and allowed stream water to flow through the trap as efficiently as possible (see Figures 8-12).



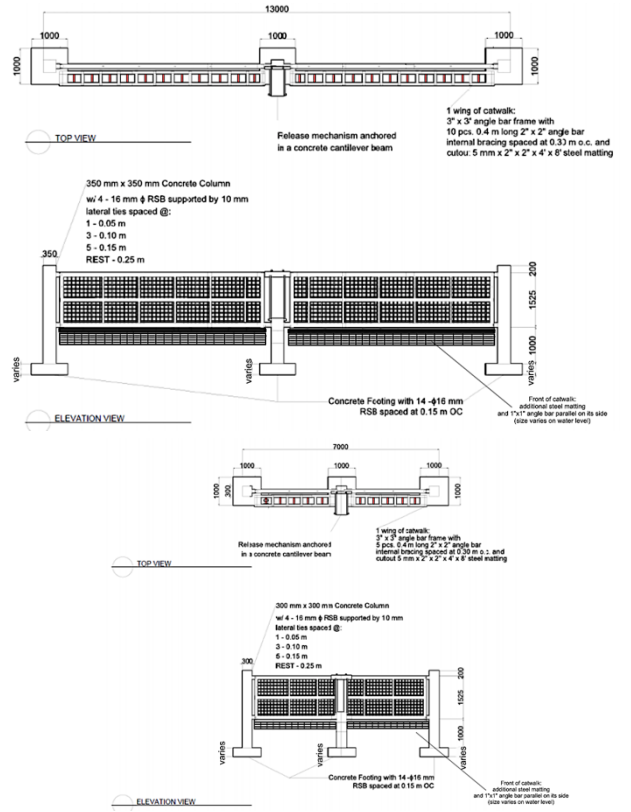


Figure 8-12. The (a - e) Designs and (f) Actual photo of the Collapsible-typed Trash Trap installed in Brgy. Langkaan I, Dasmariñas City, Cavite.

Thereafter, the succeeding installed units were all collapsible-typed. In 2021, five (5) units were installed in the Municipality of Silang and Cities of Gen. Trias and Trece Martires, Cavite. In 2022, 10 units were installed in the Municipalities of Ternate, Tanza, Rosario, Naic, Mendez, Magallanes and General Emilio Aguinaldo, Cavite.

Recently, one (1) unit was installed in the City of Bacoor as per request of Sen. Cynthia Villar so that the garbage in the waterways of Cavite will no longer reach the waterways within the jurisdiction of the City of Las Piñas, Metro Manila because it is situated in the boundary of Bacoor City and Las Piñas, City (see Figure 13). The unit was already completed on February 03, 2023.

Figure 13. The Actual photo of the Collapsible-typed Trash Trap installed in Brgy. San Nicholas III, Bacoor City, Cavite.

To date, there are forty-nine (49) installed trash traps within the river systems of Cavite which made the collection of solid wastes easier, which in turn assisted in alleviating water pollution.

Relative to the trash trap installation project, DENR – PENRO Cavite has shouldered the whole expenses thru the MBSCMO fund, starting from installation until the continuous maintenance efforts to be able to attain its goal.

The Solid Waste Collection from the Installed Trash Traps

MBSCMO Cavite is continuously consolidating the data obtained by the hired River Rangers from their daily solid waste collection reports on the installed trash traps (see Annex). The trapped wastes are being collected, weighed, segregated and transferred into the designated pick-up points by the assigned RRs to facilitate hauling by the contracted garbage hauler of the respective cities and municipalities. Hence, Team Leaders per city/municipality are being trained in data collection.

The first year of monitoring the efficiency of the installed trash traps started in 2021. Based on the gathered data, it was found that out of the 38 installed trash traps, 50% or 19 units are functional and in good condition (FGC), 13% or five (5) units are functional with minor damaged (FMD), 13% or five (5) units are newly installed, 21% or eight (8) units are not functional and severely damaged (NFSD), and 3% or one (1) unit has been washed-out due to typhoon Fabian.

Likewise, out of the classified trash traps as FGD and FMD, only 58% or 14 units have waste collection, but

it is noticeable that there is also waste collection in 50% or four (4) trash traps classified as NFSD. Hence, the total volume of waste collected in the 38 installed trash traps in 2021 is 669,091 kgs (see Table 1).

Table 1. Solid Waste Collection from the Installed Trash Traps for CY 2021

No.	Year Est.	City/ Municipality	Barangay	Coordinates		Approx. Length (M)	Status	River System	Volume Collected (Kg)
				Northing	Easting				
1	2019	City of Bacoor	Molino VI (Phase 4)	14.4169	120.9758	10	FGC	Zapote River	No collection
2	2019	City of Bacoor	Aniban IV	14.4564	120.9686	8	FGC	Zapote River	No collection
3	2019	City of Bacoor	Molino VI (Woodwinds)	14.4119	120.9869	8	FGC	Zapote River	No collection
4	2019	City of Bacoor	Ligas I	14.4539	120.9681	4	FGC	Zapote River	206,883
5	2019	City of Bacoor	Ligas II	14.4515	120.9661	8	FGC	Zapote River	199,971
6	2019	City of Bacoor	Molino V	14.3963	120.9688	6	FGC	Zapote River	84,801
7	2019	City of Bacoor	Real 2	14.4354	120.9499	8	FGC	Imus River	122,127
8	2020	Dasmariñas City	Salawag (Pasong Tinta)	14.351984	120.977131	6	FGC	Imus River	No collection
9	2020	Dasmariñas City	Salitran III	14.352385	120.946027	6	NFSD	Imus River	No collection
10	2020	Dasmariñas City	Salawag (Prinza Dam)	14.350329	120.971077	8	FMD	Imus River	No collection
11	2020	Dasmariñas City	Burol II/Sta. Fe/Area C	14.323573	120.965355	4	FMD	Imus River	No collection
12	2020	Dasmariñas City	Sampaloc I (Robinsons Pala Pala)	14.300431	120.952461	8	NFSD	Imus River	No collection
13	2020	Dasmariñas City	Langkaan I (FCIE)	14 17'34"	120 56'6"	6	NFSD	Ylang-ylang River	No collection
14	2020	Dasmariñas City	Sabang	14.349885	120.924361	4	FGC	Imus River	No collection
15	2020	General Trias City	Navarro	14.3846	120.885274	8	FMD	Ylang-ylang River	400
16	2020	General Trias City	Santiago	14.34142	120.90905	12	FMD	Ylang-ylang River	600
17	2021	General Trias City	Manggahan	14.29154	120.906051	17	Newly installed	Cañas River	-
18	2021	General Trias City	Biclatan	14.28217	120.90541	12	Newly installed	Cañas River	-
19	2020	Imus City	Toclong IA	14.431437	120.932774	5	NFSD	Imus River	24,600
20	2020	Imus City	Anabu 2F	14.36135	120.92922	8	NFSD	Imus River	8,960
21	2020	Imus City	Alapan IC	14.405483	120.920958	6	FGC	Imus River	1,800
22	2020	Imus City	Malagasang 2B	14.369541	120.918914	6	FGC	Imus River	5,900
23	2020	Imus City	Malagasang 2C	14.354327	120.923545	4	FGC	Imus River	No collection
24	2019	Imus City	Pasong Buaya II	14.38721	120.96225	8	FGC	Imus River	3,000
25	2019	Imus City	Buhay na Tubig	14.420229	120.949706	6	FGC	Imus River	3,600
26	2020	Kawit	Toclong	14.42254	120.91512	6	FGC	Ylang-ylang River	No collection
27	2019	Kawit	Aplaya	14.45208	120.91813	8	FGC	Ylang-ylang River	470
28	2017	Naic	Palangue 2&3	14.250749	120.837228	5	FGC	Labac River	595
29	2017	Naic	San Roque	14.310035	120.7706	12	FGC	Labac River	1,050
30	2017	Naic	Bucana Sasahan	14.329549	120.763565	8	FGC	Labac River	800
31	2020	Silang	Sabutan	14.23297	120.97834	6	NFSD	Imus River	No collection
32	2020	Silang	Luksuhin	14.2104	120.9562	8	FMD	Ylang-ylang River	No collection
33	2021	Silang	Adlas	14.256	120.9695	8	Newly installed	Ylang-ylang Rio Grande River	-
34	2020	Tanza	Biwas	14.39993	120.8558	8	Washed-out due to typhoon Fabian	Cañas River	1,075
35	2020	Tanza	Daang Amaya I	14.39426	120.85771	8	NFSD	Cañas River	1,489
36	2020	Tanza	Paradahan I	14.32065	120.86688	12	NFSD	Cañas River	970
37	2021	Trece Martires City	Inocencio	14.26329	120.87545	10	Newly installed	Labac River	-
38	2021	Trece Martires City	Luciano	14.27813	120.86538	8	Newly installed	Labac River	-
			GRAND TOTAL						669,091

On the second year of monitoring, it was found that out of the 48 installed trash traps, 58.3% or 28 units are FGC, 8.3% or four (4) units are FMD, 8.3% or four (4) units are NFSD, 21% or 10 units have been washed-out due to typhoon Paeng, and 4.1% or two (2) units have been dismantled due to ongoing revetment project of the Department of Public Works and Highways (DPWH). The dismantled units in Brgy. Sabutan, Silang and Brgy. Molino VI (Phase 4), Bacoor City will be reinstalled by DPWH once the soil erosion measure/riprap in the aforementioned locations are finished. Further, out of the classified trash traps as FGD and FMD, only 6.25% or two (2) units have no garbage collection, but it was noted that there is garbage collection in 96% or 46 installed trash traps. Hence, the total volume of waste collected in the 48 installed trash traps in 2022 is 928,754 kgs (see Table 2).

Table 2. Solid Waste Collection from the Installed Trash Traps for CY 2022

No.	Year Est.	City/ Municipality	Barangay	Coordinates		Approx. Length (M)	Status	River System	Volume Collected (Kg)
				Northing	Easting				
1	2019	City of Bacoor	Molino VI (Phase 4)	14.4169	120.9758	10	Dismantled due to revetment project of DPWH	Zapote River	670,695.4
2	2019	City of Bacoor	Aniban IV	14.4564	120.9686	8	FGC	Zapote River	(combined)
3	2019	City of Bacoor	Molino VI (Woodwinds)	14.4119	120.9869	8	FMD	Zapote River	(combined)
4	2019	City of Bacoor	Ligas I	14.4539	120.9681	4	NFSD (Subject for repair)	Zapote River	(combined)
5	2019	City of Bacoor	Ligas II	14.4515	120.9661	8	FGC	Zapote River	(combined)
6	2019	City of Bacoor	Molino V	14.3963	120.9688	6	NFSD	Zapote River	(combined)
7	2019	City of Bacoor	Real 2	14.4354	120.9499	8	FGC	Imus River	(combined)
8	2020	Dasmariñas City	Salawag (Pasong Tinta)	14.351984	120.977131	6	Washed-out due to typhoon Paeng	Imus River	91,710
9	2020	Dasmariñas City	Salitran III	14.352385	120.946027	6	Washed-out due to typhoon Paeng	Imus River	(combined)
10	2020	Dasmariñas City	Salawag (Prinza Dam)	14.350329	120.971077	8	Washed-out due to typhoon Paeng	Imus River	(combined)
11	2020	Dasmariñas City	Burol II/Sta. Fe/Area C	14.323573	120.965355	4	FGC	Imus River	(combined)
12	2020	Dasmariñas City	Sampaloc I (Robinsons Pala Pala)	14.300431	120.952461	8	Washed-out due to typhoon Paeng	Imus River	(combined)

No.	Year Est.	City/ Municipality	Barangay	Coordinates		Approx. Length (M)	Status	River System	Volume Collected (Kg)
				Northing	Easting				
13	2020	Dasmariñas City	Langkaan I (FCIE)	14 17'34"	120 56'6"	6	FGC	Ylang-ylang River	(combined)
14	2020	Dasmariñas City	Sabang	14.349885	120.924361	4	FGC	Imus River	(combined)
15	2020	General Trias City	Navarro	14.3846	120.885274	8	Washed-out due to typhoon Paeng	Ylang-ylang River	5,589
16	2020	General Trias City	Santiago	14.34142	120.90905	12	Washed-out due to typhoon Paeng	Ylang-ylang River	(combined)
17	2021	General Trias City	Manggahan	14.29154	120.906051	17	NFSD	Cañas River	(combined)
18	2021	General Trias City	Biclatan	14.28217	120.90541	12	FMD	Cañas River	(combined)
19	2020	Imus City	Toclong IA	14.431437	120.932774	5	FGC	Imus River	128,587
20	2020	Imus City	Anabu 2F	14.36135	120.92922	8	FGC	Imus River	(combined)
21	2020	Imus City	Alapan IC	14.405483	120.920958	6	Washed-out due to typhoon Paeng	Imus River	(combined)
22	2020	Imus City	Malagasang 2B	14.369541	120.918914	6	FGC	Imus River	(combined)
23	2020	Imus City	Malagasang 2C	14.354327	120.923545	4	FGC	Imus River	(combined)
24	2019	Imus City	Pasong Buaya II	14.38721	120.96225	8	FGC	Imus River	(combined)
25	2019	Imus City	Buhay na Tubig	14.420229	120.949706	6	Washed-out due to typhoon Paeng	Imus River	(combined)
26	2020	Kawit	Toclong	14.42254	120.91512	6	FMD	Ylang-ylang River	6,261
27	2019	Kawit	Aplaya	14.45208	120.91813	8	FGC	Ylang-ylang River	(combined)
28	2017	Naic	Palangue 2&3	14.250749	120.837228	5	FGC	Labac River	10,643
29	2017	Naic	San Roque	14.310035	120.7706	12	FGC	Labac River	(combined)
30	2017	Naic	Bucana Sasahan	14.329549	120.763565	8	FGC	Labac River	(combined)
31	2022	Naic	San Roque (AMBS)	14.301329	120.779015	8	NFSD (ongoing repair)	Labac River	(combined)
32	2022	Naic	Makina	14.310075	120.770614	12	FGC	Labac River	(combined)
33	2020	Silang	Sabutan	14.23297	120.97834	6	Dismantled due to revetment project of DPWH	Imus River	7,586.50
34	2020	Silang	Luksuhin	14.2104	120.9562	8	FMD	Ylang-ylang River	(combined)
35	2021	Silang	Adlas	14.256	120.9695	8	FGC	Ylang-Ylang Rio Grande River	(combined)
36	2020	Tanza	Biwas	14.39993	120.8558	8	Washed-out due to typhoon Paeng	Cañas River	2,896
37	2020	Tanza	Daang Amaya I	14.39426	120.85771	8	FGC	Cañas River	(combined)
38	2020	Tanza	Paradahan I	14.32065	120.86688	12	Washed-out due to typhoon Paeng	Cañas River	(combined)
39	2022	Tanza	Amaya IV	14.38261	120.83126	5	FGC	Cañas River	(combined)
40	2022	Tanza	Borders of Julugan and Biwas	14.40563	120.84843	4	FGC	Cañas River	(combined)
41	2021	Trece Martires City	Inocencio	14.26329	120.87545	10	FGC	Labac River	2,180
42	2021	Trece Martires City	Luciano	14.27813	120.86538	8	FGC	Labac River	(combined)
43	2022	Ternate	Poblacion III	14 17'24"	120 43'0"	8	FGC	Maragondon River	20
44	2022	General Emilio Aguinaldo	Kaypaaba	14.18413	120.79254	15	FGC	Maragondon River	470
45	2022	Mendez	Palocpoc II	14.129915	120.873461	8	FGC	Maragondon River	No collection
46	2022	Magallanes	Poblacion III	14.18423	120.75534	15	FGC	Maragondon River	365
47	2022	Rosario	Ligtong IV	14.424848	120.86655	8	FGC	Ylang-ylang River	902
48	2022	General Mariano Alvarez	Maderan	14.2846	120.9961	8	FGC	Biñan River	No collection
					GRAND TOTAL				**928,754**

Due to time restriction, the third year of monitoring covers only until the 3rd quarter of 2023. It was found that out of the 49 installed trash traps, 45% or 22 units are FGC, 22% or 11 units are FMD, 2% or one (1) unit is not functional but in good condition (NFGC) and unfortunately 31% or 15 units are not functional and severely damaged (NFSD). Both minor and severely damaged were incurred during the onslaught of heavy rains from previous months and typhoons from previous years. At present, the two (2) units noted as NFSD are located in Brgy. Sabutan, Silang and Brgy. Molino VI (Phase 4), Bacoor were dismantled by DPWH due to revetment project. However, the said office will reinstall the dismantled trash traps once the soil erosion measure/riprap in the aforementioned locations are finished. Similarly, out of the classified trash traps as FGD and FMD, only 6% or two (2) units have no garbage collection but it was noted that there is garbage collection in 82% or 40 installed trash traps. Hence, the total volume of waste collected (as of 3rd quarter 2023) in the 49 installed trash traps in 2023 is 439,382 kgs (see Table 3).

Table 3. Solid Waste Collection from the Installed Trash Traps for CY 2023

No.	Year Est.	City/Municipality	Barangay	Coordinates		Approx. Length (M)	Status	River System	Volume Collected (Kg)
				Northing	Easting				
1	2019	City of Bacoor	Molino VI (Phase 4)	14.4169	120.9758	10	NFSD	Zapote River	2,213
2	2019	City of Bacoor	Aniban IV	14.4564	120.9686	8	NFSD	Zapote River	53,036
3	2019	City of Bacoor	Molino VI (Woodwinds)	14.4119	120.9869	8	FGC	Zapote River	13,870
4	2019	City of Bacoor	Ligas I	14.4539	120.9681	4	FGC	Zapote River	53,922
5	2019	City of Bacoor	Ligas II	14.4515	120.9661	8	FMD	Zapote River	71,951.40
6	2019	City of Bacoor	Molino V	14.3963	120.9688	6	FGC	Zapote River	67,139
7	2019	City of Bacoor	Real 2	14.4354	120.9499	8	FMD	Imus River	67,801.60
8	2023	City of Bacoor	San Nicholas III	14.4174	120.9688	6	FMD	Zapote River	No Collection
9	2020	Dasmariñas City	Salawag (Pasong Tinta)	14.351984	120.977131	6	NFSD	Imus River	1,650
10	2020	Dasmariñas City	Salitran III	14.352385	120.946027	6	NFSD	Imus River	No Collection
11	2020	Dasmariñas City	Salawag (Prinza Dam)	14.350329	120.971077	8	FGC	Imus River	No Collection
12	2020	Dasmariñas City	Burol II/Sta. Fe/Area C	14.323573	120.965355	4	NFSD	Imus River	1,770
13	2020	Dasmariñas City	Sampaloc I (Robinsons Pala Pala)	14.300431	120.952461	8	FGC	Imus River	No Collection
14	2020	Dasmariñas City	Langkaan I (FCIE)	14 17'34"	120 56'6"	6	NFSD	Ylang-ylang River	1,045
15	2020	Dasmariñas City	Sabang	14.349885	120.924361	4	FGC	Imus River	2,600
16	2020	General Trias City	Navarro	14.3846	120.885274	8	NFSD	Ylang-ylang River	No Collection
17	2020	General Trias City	Santiago	14.34142	120.90905	12	FMD	Ylang-ylang River	710
18	2021	General Trias City	Manggahan	14.29154	120.906051	17	FGC	Cañas River	287
19	2021	General Trias City	Biclatan	14.28217	120.90541	12	FMD	Cañas River	339

No.	Year Est.	City/Municipality	Barangay	Coordinates		Approx. Length (M)	Status	River System	Volume Collected (Kg)
				Northing	Easting				
20	2020	Imus City	Toclong IA	14.431437	120.932774	5	FGC	Imus River	22,244
21	2020	Imus City	Anabu 2F	14.36135	120.92922	8	FMD	Imus River	No Collection
22	2020	Imus City	Alapan IC	14.405483	120.920958	6	FGC	Imus River	15,071
23	2020	Imus City	Malagasang 2B	14.369541	120.918914	6	FMD	Imus River	5,907
24	2020	Imus City	Malagasang 2C	14.354327	120.923545	4	FGC	Imus River	3,994
25	2019	Imus City	Pasong Buaya II	14.38721	120.96225	8	FGC	Imus River	15,253
26	2019	Imus City	Buhay na Tubig	14.420229	120.949706	6	NFSD	Imus River	No Collection
27	2020	Kawit	Toclong	14.42254	120.91512	6	NFSD	Ylang-ylang River	1,170
28	2019	Kawit	Aplaya	14.45208	120.91813	8	NFSD	Ylang-ylang River	582
29	2017	Naic	Palangue 2&3	14.250749	120.837228	5	FGC	Labac River	3,814
30	2017	Naic	San Roque	14.310035	120.7706	12	FGC	Labac River	2,304
31	2017	Naic	Bucana Sasahan	14.329549	120.763565	8	FMD	Labac River	523
32	2022	Naic	San Roque (AMBS)	14.301329	120.779015	8	NFSD	Labac River	No Collection
33	2022	Naic	Makina	14.310075	120.770614	12	FGC	Labac River	1,392
34	2020	Silang	Sabutan	14.23297	120.97834	6	NFSD	Imus River	No Collection
35	2020	Silang	Luksuhin	14.2104	120.9562	8	FGC	Ylang-ylang River	1,746
36	2021	Silang	Adlas	14.256	120.9695	8	FMD	Ylang-Ylang Rio Grande River	2,431
37	2020	Tanza	Biwas	14.39993	120.8558	8	NFSD	Cañas River	1,510
38	2020	Tanza	Daang Amaya I	14.39426	120.85771	8	FGC	Cañas River	6,750
39	2020	Tanza	Paradahan I	14.32065	120.866888	12	NFSD	Cañas River	1,550
40	2022	Tanza	Amaya IV	14.38261	120.83126	5	FGC	Cañas River	4,300
41	2022	Tanza	Borders of Julugan and Biwas	14.40563	120.84843	4	NFSD	Cañas River	1,550
42	2021	Trece Martires City	Inocencio	14.26329	120.87545	10	FGC	Labac River	166
43	2021	Trece Martires City	Luciano	14.27813	120.86538	8	FMD	Labac River	498
44	2022	Ternate	Poblacion III	14 17'24"	120 43'0"	8	NFGC	Maragondon River	484
45	2022	General Emilio Aguinaldo	Kaypaaba	14.18413	120.792554	15	FGC	Maragondon River	2,319
46	2022	Mendez	Palocpoc II	14.129915	120.873461	8	FGC	Maragondon River	390
47	2022	Magallanes	Poblacion III	14.18423	120.75534	15	FGC	Maragondon River	584
48	2022	Rosario	Ligtong IV	14.424848	120.86655	8	FGC	Ylang-ylang River	496
49	2022	General Mariano Alvarez	Maderan	14.2846	120.9961	8	FMD	Biñan River	4,019
				GRAND TOTAL					**439,382**

Based on the processed data, it is noticeable that within the three (3)-year period (2021–2023) of the trash trap installation project, the average functional trash trap is 66% while the average non-functional trash trap is 34%. However, the installed units had already captured a total volume of 2,037,227 kgs, or equivalent to 2,005.1 tons of mixed wastes, an indication that RRs are also conducting clean-up activities in trash traps classified as NFSD (see Table 4). Nonetheless, the efficiency of these traps can be maximized if all units are functional and are maintained in good condition. The huge volume of solid wastes that are being trapped and are not able to reach the Manila Bay area is a great help in the ongoing efforts to clean up, rehabilitate, and preserve the said valuable waterbody.

Table 4. Summary of Trash Trap Status relative to the Volume of Wastes Collected.

Year	Average Percentage of Functional Trash Trap	Average Percentage of Non-Functional Trash Trap	Total Volume of Wastes Collected (Kg)	(+) / (-) In Waste Collected (Kg)	% (+) / % (-) In Waste Collected
2021	66%	34%	669,091	—	—
2022			928,754	259,663	+72%
2023			439,382	-489,372	-211%
	GRAND TOTAL		**2,037,227**		

Likewise, it has been observed that an increase of 72% or 259,663 kgs (256 tons) of waste collected in 2022 along the rivers/tributaries/waterways is because of the outbreak of the pandemic, wherein most of the wastes collected are composed of COVID-19-related healthcare wastes such as facemasks and face shields. It was in 2023 (as of the 3rd quarter), when a notable decrease of -211% or -489,372 kgs (482 tons) in solid waste collection from the installed trash traps was recorded. The aforementioned positive result is the outcome of various interventions being undertaken by MBSCMO Cavite, such as intensified Communication, Education, and Public Awareness (CEPA) Campaign among the residents, especially those living in the easement areas/waterways. The establishment of barangay ecological gardens and the installation of billboards and vertical fences with gardens are useful in proper waste management.

CONCLUSION AND RECOMMENDATIONS

The uncontrolled solid waste generation ending up in the waterways of the Province of Cavite, draining into Manila Bay, is a serious environmental problem that threatens the natural environment as well as the biodiversity in the Manila Bay Region. In support of the continuous efforts of the Manila Bay Rehabilitation Program (MBRP) as part of the Supreme Court Continuing Mandamus Order, DENR–PENRO Cavite, through MBSCMO, has installed 49 trash traps that are strategically located within the river systems of Cavite, for the improvement of the quality of water in the rivers and waterways draining to Manila Bay.

Similarly, the installed units will reduce the flow of solid wastes coming from the upstream, and facilitate easier collection and safe disposal, which contributes to the prevention of water pollution. Based on the processed data from 2021 – 2023 regarding the trash trap installation project, it was found that the average functional trash traps are 66%, while the average non-functional trash traps are 34%. However, the installed units had already captured a total volume of 2,037,227 kgs, or equivalent to 2,005.1 tons of mixed wastes, an indication that RRs are also conducting clean-up activities in trash traps classified as NFSD.

Moreover, the following are some of the probable situational conditions that influence the variation in solid waste collection by means of trash traps, to wit: (a) RRs were unable to visit all units since they are focused on the reported hotspot areas under their jurisdiction; (b) effective/strengthened enforcement of existing environmental laws, rules and regulations—a priority well-documented in the context of Philippine governance and anti-corruption frameworks (Santiago, 2018); and, (c) conduct of intensified Communication, Education and Public Awareness (CEPA) Campaign among the residents especially those living in the easement areas/waterways.

Nonetheless, the efficiency of these traps can be maximized if all units are functional and are maintained in good condition. Thus, all the installed units must be functional and in good condition to be able to respond to the dire need to control the additional leakage of wastes into our waterbodies. Correspondingly, it is noteworthy to state that the huge volume of solid wastes that are being trapped before reaching the Manila Bay area is of great help in the ongoing efforts to clean up, rehabilitate, and preserve the said valuable waterbody.

Recommendations

In view of the foregoing, the following are hereby recommended to wit:

1. That the 49 installed trash traps within the Province of Cavite under the Manila Bay Rehabilitation Program be turned over through a Memorandum of Agreement (MOA) to the respective Local Government Units where they are located. The said MOA will legally bind both parties to ensure collaborative efforts in the maintenance of the project to be able to serve its purpose.
2. The trash trap installation project should be replicated in applicable waterways since it is an effective measure in trapping solid wastes within waterways. The replication process should be guided by participatory planning principles and supported by transparent data management practices that align with data privacy and research ethics standards (Santiago, 2024).

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Safety First: Sustaining Workplace Practices in Small and Medium Enterprises in Albay, Philippines

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ABSTRACT

This study focused on assessing the level of Occupational Safety and Health compliance among Small and Medium Enterprises in Albay, Philippines, with particular attention to perceived compliance, local practices, challenges, and the development of policy recommendations. An explanatory sequential mixed-methods design was employed, beginning with a Likert-scale survey to measure OSH compliance across the six indicators among SMEs in the study area, followed by key informant interviews with OSH officers, medical officers, and the CEOs to provide qualitative insights that explained and enriched the survey findings. Findings revealed that Urban districts like Legazpi City and Daraga lead in compliance because of strong governance, training, and inspections, while Tabaco City and Ligao City show moderate compliance but struggle with cultural resistance, slowing adoption of safety practices, and rural districts such as Polangui, Oas, Guinobatan, and Camalig lag behind due to weak incentives, limited resources, and poor training access. The SME-Integrated OSH Compliance Model ties these insights together, showing that governance, culture, inspections, incentives, and training must work together to build a sustainable safety culture across Albay. The assessment of SME-Integrated OSH compliance in Albay highlights a clear tiered performance across districts, with urban centers leading through strong governance and structured training, mid-tier districts struggling with cultural adoption, and rural areas lagging due to resource and training gaps. Urban best practices such as leadership commitment, inspections, and incentives, offer replicable models, but persistent challenges like weak incentives, resistance to change, and limited resources confirm SMEs' structural disadvantages compared to larger firms. Addressing these gaps through targeted interventions and support mechanisms is essential to ensure equitable compliance outcomes. The SME-Integrated OSH Compliance Model provides a comprehensive framework that integrates governance, culture, inspections, incentives, and skills development, converging on the goal of building a sustainable workplace safety culture across Albay. The practical implication of this study is that policymakers must apply a tiered approach, replicating urban best practices, strengthening communication in mid-tier districts, and expanding incentives and training access in rural SMEs to build a sustainable workplace safety culture in Albay.

Keywords: *OSH, SME, OSH-Compliance, Compliance Incentive, Risk Management, Organizational Commitment, Urban, Rural*

INTRODUCTION

Occupational safety and health (OSH) standards play a pivotal role in ensuring the well-being of employees and maintaining a secure work environment (WHO, 2023). With about 60% of the global population is employed, and every worker is entitled to a work environment that is secure and promotes well-being (WHO, 2023). Decent work provides not only income but also fosters confidence, purpose, and a sense of achievement. It provides opportunities for positive relationships and community inclusion, offering a foundation for structured routines and numerous other benefits. It fosters positive relationships, community inclusion, and structured routines that benefit individuals and society. For those facing mental health challenges, decent work becomes even more important, supporting recovery and improving social functioning (Mabona, et al., 2022). According to Mabona et al. (2022), workplaces that prioritize OSH reduce stress and conflict, improve staff retention, and increase productivity. Conversely, they

stressed that when safety systems are weak, especially for vulnerable workers, job satisfaction and performance decline, attendance suffers, and employment opportunities may be lost. As industries evolve and the workplace grows more complex, assessing OSH-compliance becomes increasingly necessary (Tamers et al., 2020; Mabona et al., 2022).

Globally, the OSH has been recognized as a critical aspect of workforce management, e.g., the International Labor Organization (ILO) and the World Health Organization (WHO). The ILO's OSH Convention No. 155 and its 2002 Protocol emphasize the responsibility of government and employees to uphold workers' right to safe and healthy workplace (Wadsworth & Walters, 2019). In the United States of America, the Occupational Safety and Health Administration was created following the passage of the OSH Act of 1970 to ensure workers have a safe and healthy workplace. This was achieved by setting rules and offering training in the workplace (Centers for Disease Control and Prevention, 2022; Fairfax, 2020). A strong organizational commitment to safety helped reduce accidents and hazards (Naji et al., 2021; Centers for Disease Control and Prevention, 2022; Mabona et al., 2022). Proper safety training equips employees with the skills they need to handle risks, while OSH-compliance ensures that industries follow legal and ethical practices (Dyreborg et al., 2022; Tamers et al., 2020).

In the Philippines, the legislative framework for OSH is anchored on Republic Act No. 11058. Enacted in 2018, this mandate requires employees to maintain safe working conditions and provide necessary safety equipment and training. The Department of Labor and Employment (DOLE) of the Philippines enforces OSH regulations and issues compliance directives such as Department Order No. 198 to implement the OSH Standards Act of 2018. Small and medium Enterprises (SMEs) in the Philippines are presently challenged in meeting OSH-compliance standards. At the local level, industries in Albay, including agriculture, construction, and manufacturing, are required to comply with OSH regulations. Yet, compliance remains uneven, and employers struggle to afford standard safety equipment and/or send their workers to training.

This study seeks to identify areas for improvement and ensure employees are properly equipped with knowledge and skills.

MATERIALS AND METHODS

This study used an explanatory sequential mixed methods design, starting with a survey to measure or describe the OSH compliance level among SMEs in Albay, Philippines, and then followed up with the OSH officers, medical officers, and CEOs, to explain the results of the survey. A likert scale was used to combine survey data and administrative insights to describe the level of compliance and get a clear understanding of OSH compliance of selected SMEs in the study area.

The approach structured the questionnaire to assess OSH compliance across six key indicators: regulatory standards, incentives, inspections, enforcement, information dissemination, and training. Respondents rated their organizations using a Likert scale, allowing for a systematic evaluation of perceived compliance levels. The approach provides a consistent framework for comparing practices across SMEs and identifying areas for deeper inquiry.

To complement the survey data, the study conducted targeted interviews with key informants from selected SMEs in three congressional districts of Albay Province. Participants were chosen based on strategic criteria to ensure representation of samples facing compliance challenges. The interviews explored behavioral, operational, and administrative factors affecting OSH implementation. Thematic coding was applied to extract patterns and insights that could not be captured through quantitative methods alone.

By combining survey data with interview findings, the study adopted a mixed-method approach to develop a comprehensive policy framework. This integration allowed for the construction of the SME-integrated OSH Compliance Model, as shown in Figure 1, which aligns technical standards with organizational strategies. The model was designed to reflect both the formal structure and lived experiences of SMEs, ensuring that proposed interventions are grounded, practical, and responsive to real-world conditions.

RESULTS AND DISCUSSION

Table 1 presents the summary of OSH compliance among selected SMEs in Albay, Philippines. It highlights the sample SME names (coded by district), the compliance indicators assessed, their mean scores, and interpretations.

By linking each compliance theme, such as training, organizational commitment, inspections, incentives, enforcement, and risk management to specific SMEs, the table discloses both strengths and gaps in

workplace safety practices. This structured view shows that SMEs demonstrate a strong commitment to training and policy formulation, but they face challenges in sustaining compliance incentives and proactive risk management.

Table 1. Matrix of OSH Compliance, Practices, and Challenges in Albay SMEs

Indicators	Rating	Sample SMEs by District	Compliance Level	Best Practices	Challenges	Findings
Training initiatives (mandatory training, drills, refresher courses)	4.60-4.67	District 1 (Legazpi) / District 2 (Daraga)	Very High	Structured training programs, regular drills	Resource gaps in rural areas	SMEs prioritize training as their strongest compliance tool Training is the highest-performing area, ensuring workers are well-prepared
Formulation of regulatory standards (policies, OSH committees, integration)	4.40 – 4.60	District 2 (Daraga) / District 3 (Tabaco)	High	Embedding OSH into policies and committees	Limited resources for smaller SMEs	SMEs embed OSH into decision-making despite resource challenges Strong structural commitment shows maturity in compliance culture
Inspection by regulatory agencies (regular inspections, documentation, audits)	3.93-4.27	District 1 (Legazpi) / District 3 (Tabaco)	Moderate to High	Cooperation with external audits	Weak transparency to employees	SMEs cooperate with external oversight but transparency to employees is weaker Compliance is high in inspections, but internal communication needs improvement
Financial incentives, government contract priority, employee rewards	3.20 – 3.93	District 2 (Daraga) / District 3 (Tabaco)	Low to Moderate	Employee recognition, contract prioritization	Lack of subsidies and external motivation	SMEs lack external financial motivation, treating safety as a cost Incentives are the weakest area, creating sustainability challenges
Enforcement by regulatory agencies (sanctions, accountability, legal awareness)	3.80 – 4.33	District 1 (Legazpi) / District 2 (Daraga)	Moderate to High	Legal awareness, accountability systems	Compliance driven by fear of sanctions	SMEs comply mainly to avoid penalties, showing reactive rather than proactive behavior Fear of sanctions drives compliance, but proactive safety culture is limited
Dedicated OSH committees, integration into company policies	4.40 – 4.60	District 3 (Tabaco) / District 2 (Daraga)	High	Strong internal OSH committees	Maintaining consistency in smaller firms	SMEs demonstrate strong internal commitment to safety structures OSH is integrated into organizational culture, ensuring long-term adherence

The SME-Integrated OSH Compliance Model, as shown in Figure 1, is a policy framework developed to strengthen workplace safety among small and medium enterprises (SMEs) in Albay. It was designed by combining quantitative survey results with qualitative interview insights, ensuring that both statistical evidence and real-world experiences shaped its structure. The model organizes the determinants of OSH compliance, such as regulatory mechanisms, industry context, challenges, and best practices, into a layered framework that explains how compliance can be achieved and sustained.

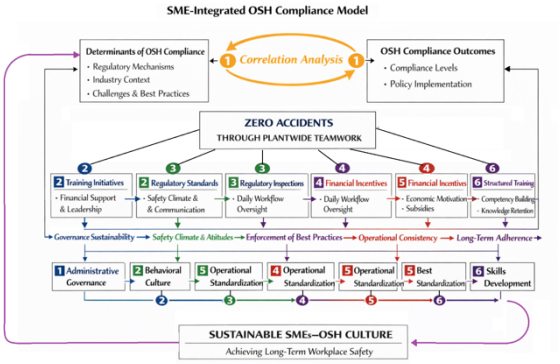

Figure 1. SME-Integrated OSH Compliance Model (Livica, 2026)

The Benchmarking Matrix serves as a practical tool for policymakers and industry leaders to evaluate how compliance drivers (arrows) connect to strategic domains and how these domains perform across districts in Albay. By mapping arrows to governance, culture, standardization, best practices, and skills development, the matrix provides a clear picture of strengths, weaknesses, and intervention priorities.
This policy brief highlights the tiered performance across districts:

- Urban centers (Legazpi, Daraga) demonstrate strong governance and compliance, setting benchmarks for replication.
- Mid-tier districts (Tabaco, Ligao) show moderate adoption of safety culture, requiring communication-focused interventions.
- Rural districts (Polangui, Oas, Guinobatan, Camalig) face resource shortages, weak incentives, and limited training access, underscoring the need for targeted support.

Table 2 shows the convergence on the capstone goal: building a Sustainable SMEs–OSH Culture, consistent with ILO (2020) and Micheli et al. (2018), who confirm that integrated approaches—combining governance, culture, inspections, incentives, and training—are the most effective pathway to resilient compliance.
Each arrow explains how the compliance model, as shown in Figure 1, works in real life, and the

benchmarking matrix shows which districts are strong and which are weak in those areas. Urban districts lead, mid-tier districts struggle with culture, and rural districts face shortages in resources and training.

Table 2. OSH-SME Benchmarking in Albay, Philippines

Arrow	Role/Function	Strong Districts (Benchmark)	Weak Districts (Gap)
Arrow 1	Links rules, context, and challenges with compliance results	Legazpi, Daraga – strong feedback loop between policy and outcomes	Rural districts – weak correlation due to limited resources
Arrow 2	Training sustains leadership and financial support	Legazpi, Daraga – governance strengthened by structured training	Rural areas – governance gaps from limited training access
Arrow 3	Standards foster communication and reduce resistance	Urban centers – clearer adoption of safety culture	Tabaco, Ligao – moderate compliance; cultural barriers persist
Arrow 4	Inspections embed safety into daily workflows	Urban districts – regular audits sustain standardization	Polangui, Guinobatan – weak enforcement, poor workflow integration
Arrow 5	Incentives motivate SMEs to sustain compliance	Urban districts – stronger incentive structures	Rural districts – weakest incentives, lack subsidies and recognition
Arrow 6	Structured training ensures competency retention	Urban districts – accessible training programs	Oas, Camalig – severe training gaps, weak leadership support

CONCLUSION

The compliance assessment across Albay's SMEs reveals a stratified performance landscape, with urban districts such as Legazpi and Daraga leading due to strong oversight and inspections, mid-tier districts like Tabaco and Ligao showing moderate compliance shaped by cultural resistance, and rural districts consistently lagging because of resource shortages and weak incentives. This stratification confirms the need for a tiered policy approach that aligns interventions with district-specific realities, ensuring that governance structures and compliance mechanisms are tailored to local contexts.

Urban districts demonstrate that strong governance, structured training, and consistent inspections are the most effective drivers of compliance. Their integration of safety into daily operations, backed by leadership commitment and financial support, highlights replicable models that can be extended to other districts. Incentive structures in these areas further motivate SMEs to adopt best practices, reinforcing the importance of combining regulatory enforcement with positive reinforcement to sustain workplace safety culture.

Despite these successes, persistent barriers undermine progress. Weak incentives in rural areas, cultural resistance in mid-tier districts, leadership gaps in micro-enterprises, and resource constraints across disadvantaged regions confirm the structural disadvantages SMEs face compared to larger firms. These challenges emphasize the urgency of targeted interventions—financial subsidies, communication campaigns, leadership development, and expanded training access—to close compliance gaps and ensure equitable safety outcomes across all districts.

SME-Integrated OSH Compliance Model provides a comprehensive framework that organizes compliance drivers into four domains: Administrative Governance, Behavioral Culture, Operational Standardization, and Skills Development. By linking training, standards, inspections, incentives, and structured training to these domains, the model converges on the capstone goal of a Sustainable SMEs–OSH Culture. This integrated approach, consistent with global insights from ILO (2020) and Micheli et al. (2018), confirms that combining governance, culture, inspections, incentives, and training is the most effective pathway to resilient compliance and long-term workplace safety in Albay.

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Sustaining Local Enterprise: Adaptive MSMEs in Flood-Prone Areas in the Third District of Albay, Philippines

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ABSTRACT

This paper develops and presents an Integrated Logical Framework for MSME Capability Context in Flood Risk Management in the 3rd District of Albay, synthesizing government support, recurring challenges, and best practices into a diagnostic and developmental model that strengthens enterprise resilience, continuity, and community safety within the Quinali "A" Watershed. The study employed a descriptive-assessment method using surveys, interviews, and document reviews, guided by structured rubrics to evaluate MSMEs' flood risk management capabilities, practices, government support, and resilience gaps in the study area. The study found that MSMEs in Oas, Polangui, and Libon demonstrate moderate capability (2.5 to 3.4 rating) in flood risk management, with strengths in asset protection and adaptive operations but persistent weakness in financial preparedness and government support. Best practices were largely adopted (3.5 to 4.4) in Oas, while Polangui and Libon showed only partial adoption (2.5 to 3.4), reflecting uneven resilience capacities across municipalities. Overall, MSMEs "often" (3.4 to 4.4) encounter gaps in finance, market retention, and policy implementation, underscoring the need for target interventions, strong PPP engagement, and proactive government support to achieve sustainable resilience.

Keywords: *MSMEs, Flood Risk, Business Continuity, DRR, Safety, Economic Development*

INTRODUCTION

The Quinali "A" Watershed in Albay has been the subject of several studies on multi-hazard impacts and flood risk (Madriaga, 2023; Awah, et al., 2024), including works by Singson et al. (2023), Mendoza et al. (2025), and the Asia-Pacific Network for Global Change Research (2022), which highlight its vulnerability (Mendoza et al., 2025) to floods and other hazards. Hydrologic modeling studies further emphasize the watershed's floodplain dynamics, underscoring the need for localized MSME resilience frameworks (Bañares et al., 2024; Napay & Luyun, 2018).

MSMEs in flood-prone municipalities of the Quinali "A" Watershed, particularly Oas, Polangui, and Libon, face significant challenges in flood risk management due to the absence of localized frameworks, leaving them vulnerable to operational disruptions and long-term sustainability risks (Quesada-Román et al., 2025). Flood risk method for scarce-data catchments and municipalities (Quesada-Román et al., 2025). While broader studies on MSME resilience exist (Agarwal et al., 2023; Gupta & Singh, 2023; Supari & Anton. 2022; Anggadwita. 2021; Anatan, 2021), localized research remains scarce, with limited data on disaster risk reduction integration, economic losses, and recovery mechanisms (Skouloudis, 2023; Vasquez et al., 2021; Khurana, 2021; Skivington, 2021) to develop a Capability Context Model tailored to MSMEs in the watershed, offering actionable strategies for owners, LGUs, and national agencies to strengthen preparedness, adaptive capacity, and sustainable economic development.

The conceptual framework for this study draws strength from the triangulation of Resource-Based View Theory (Agarwal et al., 2023; Barney, 1991), Resilience Theory (Ballesteros & Domingo, 2023), and Stakeholder Theory (Skouloudis, 2023) to examine how MSMEs in the Quinali "A" Watershed build adaptive capacity against flood risks. The framework provides a structured lens for analyzing resilience, highlighting four interconnected components: (i) capability, (ii) practices/strategies, (iii) gaps, (iv) challenges, and institutional support

that collectively shape MSME resilience. Figure 1 emphasizes that MSMEs' specific assets are critical for sustaining competitive advantage and resilience (Barney, 1991; Agarwal et al., 2023). Studies in the Philippines context confirm that MSMEs often face financial constraints (Vasquez et al., 2021), operational disruptions, and weak retention following flood events (Ballesteros & Domingo, 2023).

Government and institutional support, through policies, financial aid, and PPP (Bhat, 2021) initiatives, plays a pivotal role in bringing these gaps and reinforcing resilience. This aligns with stakeholder theory, which underscores the importance of coordinated actions among public and private institutions and agencies, including the MSMEs communities (Freeman, 1884; Skouloudis, 2023).

The Logical Framework for MSME Capability Context in Flood Risk Management in Albay's 3rd District, combining government support, challenges, and best practices into a model that strengthens resilience, business continuity, and community safety within the Quinali "A" Watershed.

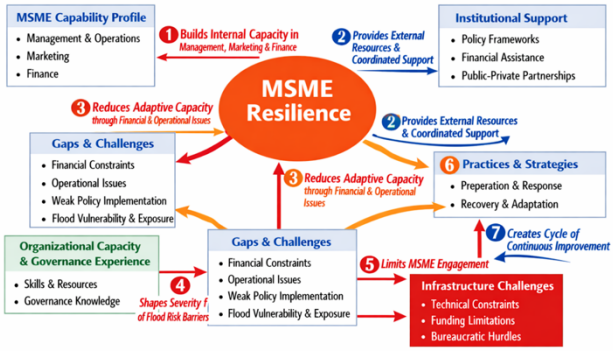

Figure 1. MSME Resilience Conceptual Framework

Figure 1 illustrates how internal capabilities, external support, and strategic practices interact to shape resilience among enterprises in flood-prone areas. Arrow 1 shows that MSME capability profiles include management, marketing, and finance. Shows how to build internal capacity to anticipate and recover from disruptions. Arrow 2 highlights how institutional support, including policies, financial aid, and partnerships, reinforces resilience by supplying coordinated resources, while arrow 3 indicates that financial constraints, operational issues, and flood vulnerability weaken resilience by reducing adaptive capacity. The arrow 4 hinted at organizational capacity and governance experience shape the severity of infrastructure challenges, while Arrow 5 shows that these challenges limit MSME participation in development processes. Arrow 6 suggests that preparedness, response, and adaptation strategies enhance resilience, and Arrow 7 completes the feedback loop, showing that resilient MSMEs refine their practices over time. It creates a cycle of continuous improvement. All of these relationships offer a structured lens for understanding how MSMEs in the Quinali "A" Watershed can strengthen their flood risk management and long-term sustainability.

MATERIALS AND METHODS

The study surveyed 95 formally registered MSMEs in flood-prone areas of Oas, Polangui, and Libon, selected from a population of 2,011 using Slovin's formula and guided by the USAID-DENR Vulnerability Assessment of the Quinali "A" Watershed. A descriptive-assessment approach was employed through surveys, interviews, and document reviews to evaluate MSMEs' flood risk management capabilities, preparedness strategies, government support, and resilience gaps.

For rubric structured analysis: Capability Profile (management, operations, marketing, finance), Practices/Strategies (preparation, response, recovery/adaption), Government Support (policy, financial aid, PPP initiatives), and Gaps and Challenges (operations, finance, policy, and market sustainability). Providing a comprehensive framework for identifying strengths, weaknesses, and actionable recommendations.

Table 1. Rubric for Analyzing MSMEs' Capability Profile on Flood Risk Management

Scale Range	Adjectival Description	Interpretation	Capability Classification
4.5 – 5.0	Very High Capability	MSME demonstrates outstanding and pro-active capability in managing flood risks, with well-established systems and practices	Strength
3.5 – 4.4	High Capability	MSME shows strong capability in flood risk management with few areas for enhancement	Strength
2.5 – 3.4	Moderate Capability	MSME has basic or average capability; needs further development to effectively manage flood risks	Weakness
1.5 – 2.4	Low Capability	MSME demonstrates limited capacity in handling flood-related risks, major improvements required	Weakness
1.0 – 1.4	Very Low Capability	MSME lacks essential capability in flood risk management; highly vulnerable and requires urgent support	Weakness

Requillas & Abante (2025)

The document review assessed MSMEs flood risk management practices across three phases: (i) preparation (risk assessment, asset protection, financial readiness, awareness), (ii) response (continuity, safety, crisis communication), and (iii) recovery/adaptation (financial recovery, rebuilding, market adaptation, long-term resilience), to determine the extent of adoption and effectiveness of strategies in sustaining enterprise resilience.

Table 2. Rubric for Assessing MSMEs' Flood Risk Management Practices/Strategies

Scale Range	Adjectival Description	Practice Classification	Interpretation
4.5 – 5.0	Fully Adopted	Best Practice	The practice is exemplary and fully integrated; serves as a model for others
3.5 – 4.4	Largely Adopted	Strong Practice	The practice is well established with consistent application and good results
2.4 – 3.4	Partially Adopted	Moderate Practice	The practice is applied inconsistently or in limited scope; needs strengthening
1.4 – 2.4	Minimally Adopted	Weak Practice	The practice is present but underdeveloped; requires significant improvement
1.0 – 1,4	Not Adopted	No Practice	The practice is not applied; urgent attention and action needed

Requillas & Abante (2025)

The document review assessed the extent of government support provided to MSMEs in flood-prone areas, focusing on policy and regulatory frameworks, financial assistance, and public-private partnership (PPP) initiatives, to determine how effectively these mechanisms enhance MSMEs' flood risk management capabilities and resilience.

Table 3. Rubric for Assessing Government Support to MSMEs to Enhance Flood Risk Management Capabilities

Response	Meaning	Implication	Recommended Action
Yes	MSMEs acknowledged receipt of government support/program	Indicates effective reach and awareness of support programs; MSMEs are potentially benefiting from such support	Sustain and possibly expand current programs; continue engaging MSMEs to improve resilience
No	MSMEs did not receive or not receiving government support	Implies lack access to or absence of government support; increases MSME vulnerability to flood risks	Improve outreach, identify service gaps, and develop inclusive programs for underserved MSMEs
Not Sure	MSMEs are unaware or unsure about government support programs	Reveals and information/awareness gap; suggests poor communication and insufficient dissemination of programs	Strengthen information dissemination efforts through local channels and partnerships with LGUs or NGOs

Requillas & Abante (2025)

The document review identified the key gaps and challenges MSMEs face in managing flood risks in Oas, Polangui, and Libon, spanning operations, finance, government support, and market sustainability, validated through stakeholder input to ensure the instrument's accuracy, relevance, and contextual fit.

Table 4. Rubric for Assessing Gaps and Challenges MSMEs Encountered in Managing Flood Risks

Scale Range	Adjectival Description	Implication	Recommended Action
4.5 – 5.0	Always	MSMEs consistently experience the gaps/challenges, persistent issues could severely affect FRM capabilities	Urgent and strategic government intervention needed; prioritize policy and resource allocation to address systematic issues
3.5 – 4.4	Often	MSMEs frequently experience gaps/challenges that regularly hamper FRM	Design targeted support programs and strengthen coordination with MSMEs to address recurring gaps
2.4 – 3.4	Sometimes	MSMEs intermittently experience gaps/challenges. Indicating a moderate level of concern	Monitor trends and implement preventive or support mechanisms to avoid escalation
1.4 – 2.4	Rarely	MSMEs frequently experience gaps/challenges implying a minor or emerging issue	Maintain current support while evaluating minor areas for improvement or risk of emerging challenges
1.0 – 1,4	Never	MSMEs do not experience gaps/challenges, effectively managed or not relevant	Sustain effective strategies and consider sharing best practices across other sectors or regions

Requillas & Abante (2025)

RESULTS AND DISCUSSION

The Integrated Logical Framework for MSME Capability Context in Flood Risk Management synthesizes government support mechanisms, recurring challenges, and best practices into a structured roadmap for resilience. This framework is anchored in the realities of MSMEs in the municipalities of Oas, Polangui, and Libon within the Quinali "A" Watershed, where enterprises face recurring flood risks that threaten both business continuity and community safety.

The Capability Context Model serves as both a diagnostic and developmental tool. It integrates management, operations, marketing, and finance strategies to strengthen enterprise continuity and mitigate flood impacts. Empirical findings reveal disparities in preparedness, financial constraints, and resilience variations, underscoring the need for a contextualized framework that aligns with local realities.

At the goal level, the Logical Framework emphasizes strengthening MSME resilience and adaptive capacity. Government support data shows moderate policy presence but weak financial assistance and PPP initiatives, while challenges highlight frequent disruptions in operations, finance, market sustainability, and policy implementation. These findings justify the framework's focus on proactive, structured interventions.

The MSME Capability profile identifies critical needs in Business Continuity Planning (BCP), DRRM, financial literacy, digital adaptation, and risk management. Addressing these gaps through training and capacity-building programs is essential to reducing vulnerabilities and enhancing preparedness.

The Best Practices Evaluation highlights strategies such as asset protection, adaptive operations, customer safety, and rebuilding mechanisms. Oas demonstrates stronger adoption of these practices, while Polangui and Libon lag behind, pointing to the need for institutionalizing and scaling successful approaches across municipalities.

The Gaps and Challenges Assessment integrates evidence that MSMEs "often" face financial constraints, weak government coordination, and market retention issues. These recurring barriers require targeted interventions, including localized financing schemes, strong PPP engagement, and inclusive policy-making.

The Capability Context Model Development combines MSME needs, best practices, and government/PPP support into a tailored framework. This ensures structured preparedness, response, and recovery strategies that evolve through stakeholder feedback.

The Implementation Framework emphasizes continuous updates, pilot testing, and collaboration to

sustain MSME empowerment. Finally, the Actionable Recommendations call for proactive policies, stable funding, and community engagement to institutionalize resilience and ensure long-term sustainability.

While the Logical Framework (LogFrame) provides structured analysis, measurable indicators, and policy alignment, the Schematic Framework offers a holistic visualization of MSME interactions within the flood risk management ecosystem. It maps stakeholders, processes, and resource flows, showing how MSMEs, government agencies, PPPs, and financial institutions collaborate to enhance preparedness. Together, these frameworks complement each other, one focusing on actionable strategies and monitoring, the other on systems thinking and visualization.

Table 5. Integrated Logical Framework for MSME Capability Context in Flood Risk Management in the 3rd District of Albay

Logical Framework Component	Findings		Proposed Development Management	Indicators/ Verification	Practical Implications
	Government Support	Challenges			
Goal	Moderate policy support; weak financial and PPP mechanisms	Frequent operational and financial disruptions	Strengthen MSME resilience and adaptive capacity	Stakeholder assessments, continuity evaluations	MSMEs must engage in resilience-building initiatives
MSME Capability Profile (Internal)	Limited training support from LGUs/DTI	Gaps in BCP, finance, and risk management	Training on BCP, DRRM, financial literacy, digital marketing, risk management	Surveys, interviews	MSMEs need active participation in capacity-building
Best Practices Evaluation	Policy frameworks partially institutionalized	Oas shows stronger adoption; Polangui/ Libon lag	Institutionalize asset protection, adaptive operations, rebuilding strategies	Case studies, performance reviews	Best practices can be scaled locally
Gaps and Challenges Assessment	Weak PPP and financial assistance	Challenges "Often" in finance, market retention, policy implementation	Target disruptions, financial losses, weak coordination, market retention	Focus groups, secondary data	Gaps are actionable with targeted interventions
Capability Context Model Development	Government support uneven across municipalities	Uneven resilience capacities	Tailored framework combining MSME needs, best practices, and Government / PPP support	Model refinement with stakeholder feedback	Framework must align with local realities
Implementation Framework	Support mechanism not consistently updated	Challenges recur frequently	Continuous updates, capacity-building, long-term empowerment	Pilot testing. collaboration	Requires sustained support from MSMEs, LGUs, partners
Actionable Recommendations	Weak visibility of Government programs	Market retention and finance issues persist	Proactive policies, stable funding, community engagement	Reports, dissemination	Recommendations feasible if resource-supported

Requillas & Abante (2025)

Table 5 provides a comprehensive roadmap for MSMEs in the 3rd District of Albay. It highlights that resilience can only be achieved through a balanced approach---strengthening internal capacities, institutionalizing best practices, and ensuring consistent government and community support. This integrated model not only enhances MSME flood preparedness but also contributes to broader DRRM strategies and sustainable local economic development.

CONCLUSION

In conclusion, the Integrated Logical Framework for MSME Capability Context in Flood Risk Management demonstrates that the resilience in flood-prone areas of the Quinali "A" Watershed can only be achieved through a balanced approach, strengthening internal capacities, institutionalizing best practices, and ensuring consistent government and community support. By combining diagnostic assessment with development strategies, the Capability Context Model provides MSMEs with structured preparedness, response, and recovery pathways that align with local realities. Ultimately, this integrated framework not only enhances enterprise continuity and adaptive capacity but also contributes to broader DRRM strategies and sustainable local economic development in Albay's 3rd District.

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A Doctrinal Analysis of the Environmental Governance Obligations of Local Government Units in the Philippines

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ABSTRACT

This paper examines the environmental governance obligations of local government units (LGUs) in the Philippines through a doctrinal analysis of the 1987 Constitution, the Local Government Code of 1991, major environmental statutes, Supreme Court jurisprudence, and local implementation tools. It argues that LGUs are not merely administrative extensions of national environmental agencies, but frontline institutions of ecological governance. The constitutional right to a balanced and healthful ecology supplies the normative foundation, while Article X of the Constitution provides the institutional basis for localizing that mandate through local autonomy, decentralization, fiscal authority, inter-LGU cooperation, and accountable local governance. The Local Government Code operationalizes these principles through the general welfare clause, devolved basic services, local legislation, consultation, intergovernmental collaboration, and environmental administration. Sectoral statutes further define LGU responsibilities in solid waste management, water and air quality, fisheries, environmental impact assessment, protected areas, climate change adaptation, disaster risk reduction, and governance accountability. Supreme Court decisions, including Oposa v. Factoran, Laguna Lake Development Authority v. Court of Appeals, Tano v. Socrates, Metropolitan Manila Development Authority v. Concerned Residents of Manila Bay, and Boracay Foundation, Inc. v. Province of Aklan, clarify that environmental duties are legally meaningful and, in proper cases, enforceable. The paper further identifies local planning, permitting, fiscal, monitoring, and enforcement tools through which LGUs give operational effect to environmental mandates. It concludes that LGU environmental governance is best understood as a system of devolved ecological responsibility: constitutionally grounded, statutorily particularized, judicially enforceable, and operationally implemented at the local level.

Keywords: *LGUs, Environmental Governance, Ecological Responsibility, Climate and Disaster Risk Governance, Solid Waste Management*

INTRODUCTION

Environmental governance in the Philippines is commonly associated with national statutes and national agencies, particularly the Department of Environment and Natural Resources (DENR), the Environmental Management Bureau (EMB), the Bureau of Fisheries and Aquatic Resources (BFAR), and other specialized regulatory bodies. This national-agency-centered view is doctrinally valid, but incomplete. A substantial portion of environmental governance occurs at the local level. Solid waste management, sanitation, drainage, land-use control, zoning, fisheries regulation, business permitting, nuisance abatement, coastal management, public consultation, tourism regulation, and enforcement of environmental ordinances are functions that directly implicate local government units (LGUs).

The legal position of LGUs in environmental governance must therefore be examined not merely as a matter of administrative convenience, but as a matter of constitutional and statutory duty. The 1987 Constitution recognizes the people's right to a balanced and healthful ecology and commands the State to protect and advance that right (CONST., art. II, sec. 16). It also protects the right to health, establishes State stewardship over natural resources, recognizes the social function of property, protects public participation and access to information, and declares public office as a public trust (CONST., art. II, secs. 15, 16, 28; art. III, sec. 7; art. XI, sec. 1; art. XII, secs. 2, 6; art. XIII, sec. 16). These provisions

situate environmental protection within a broader constitutional framework of public welfare, accountability, transparency, and ecological stewardship.

Article X of the Constitution is especially important because it supplies the institutional basis for localizing the environmental mandate. It establishes local autonomy, requires Congress to enact a Local Government Code, recognizes the fiscal authority of LGUs, and authorizes inter-LGU cooperation for purposes commonly beneficial to them (CONST., art. X, secs. 2, 3, 5–7, 13). Thus, while Article II, Section 16 provides the substantive environmental mandate, Article X provides the constitutional structure through which that mandate is implemented at the local level. Local autonomy is not merely a protection against national interference; it is also a constitutional basis for responsive, accountable, and place-specific environmental governance.

The Local Government Code of 1991 operationalizes these constitutional principles. It expressly provides that LGUs shall share with the national government the responsibility for the management and maintenance of ecological balance within their territorial jurisdictions (R.A. No. 7160, sec. 3[i]). It also authorizes LGUs, through the General Welfare Clause, to promote health and safety and enhance the people's right to a balanced ecology (R.A. No. 7160, sec. 16). It devolves basic services and facilities related to sanitation, solid waste, water supply, drainage, sewerage, flood control, environmental management, fisheries, mangrove protection, community forestry, parks, and greenbelts (R.A. No. 7160, sec. 17). It further empowers local legislative bodies to enact ordinances for environmental protection and to penalize acts that endanger the environment (R.A. No. 7160, secs. 447, 458, 468).

Environmental statutes further particularize these local responsibilities. The Ecological Solid Waste Management Act assigns primary responsibility for solid waste management to LGUs (R.A. No. 9003, sec. 10). The Philippine Clean Water Act recognizes LGU participation in maintaining and improving water quality within their territorial jurisdictions (R.A. No. 9275, sec. 20). The Philippine Clean Air Act recognizes local roles in air quality management (R.A. No. 8749). The Philippine Fisheries Code gives municipalities and cities significant authority over municipal waters and fisheries regulation (R.A. No. 8550, as amended by R.A. No. 10654). Other statutes, including the Environmental Impact Statement System, the NIPAS and ENIPAS laws, the Climate Change Act, the Disaster Risk Reduction and Management Act, and the Seal of Good Local Governance Act, further embed environmental governance in local planning, regulation, performance assessment, and accountability.

This paper argues that LGUs are frontline environmental governance institutions. Their role is not limited to assisting national agencies. They possess direct legal authority and bear direct legal responsibility in areas such as solid waste management, water quality management, air quality management, municipal fisheries, land-use regulation, local environmental planning, climate and disaster risk governance, and enforcement of environmental ordinances. Their environmental functions are grounded in the Constitution, particularized by statute, interpreted by jurisprudence, and operationalized through local plans, ordinances, permits, budgets, monitoring systems, and enforcement mechanisms.

This doctrinal position is reinforced by Philippine jurisprudence. In Oposa v. Factoran, the Supreme Court recognized the constitutional right to a balanced and healthful ecology as a legally cognizable right and articulated the doctrine of intergenerational responsibility (Oposa v. Factoran, G.R. No. 101083, July 30, 1993). In Laguna Lake Development Authority v. Court of Appeals, the Court held that local autonomy does not authorize LGUs to disregard special environmental regulation or national environmental standards (Laguna Lake Development Authority v. Court of Appeals, G.R. No. 110120, March 16, 1994). In Tano v. Socrates, the Court sustained LGU authority to enact environmental and fisheries ordinances under local police power (Tano v. Socrates, G.R. No. 110249, August 21, 1997). In Metropolitan Manila Development Authority v. Concerned Residents of Manila Bay, the Court treated statutory environmental duties as enforceable obligations that may be compelled by mandamus (MMDA v. Concerned Residents of Manila Bay, G.R. Nos. 171947–48, December 18, 2008). In Boracay Foundation, Inc. v. Province of Aklan, the Court emphasized environmental impact assessment, consultation, and compliance in relation to local development projects (Boracay Foundation, Inc. v. Province of Aklan, G.R. No. 196870, June 26, 2012).

Taken together, these constitutional provisions, statutes, and cases establish the central thesis of this paper: LGU environmental governance is a system of devolved ecological responsibility. Under this

doctrine, LGUs are constitutionally grounded, statutorily empowered, judicially accountable, and operationally equipped to protect ecological balance within their jurisdictions. Local autonomy expands LGU authority, but it also grounds LGU accountability. Environmental protection is therefore not an optional local program; it is a constitutional and statutory obligation that must be implemented through local planning, regulation, permitting, budgeting, monitoring, coordination, and enforcement.

This paper proceeds in seven parts. First, it identifies the constitutional foundations of LGU environmental governance. Second, it examines the statutory framework, particularly the Local Government Code and major environmental laws. Third, it discusses Supreme Court doctrines that clarify the enforceability and limits of LGU environmental obligations. Fourth, it identifies the implementation tools available to LGUs, including land-use plans, zoning ordinances, solid waste management plans, climate and disaster risk assessments, local permits, ECC monitoring, local environmental codes, fiscal tools, and enforcement mechanisms. Fifth, it synthesizes these materials into the doctrine of devolved ecological responsibility. Sixth, it discusses the implications of this doctrine for local environmental governance. Finally, it concludes that the effective protection of the constitutional right to a balanced and healthful ecology depends not only on national environmental agencies, but also on the capacity, willingness, and legal accountability of LGUs to perform their environmental mandates.

MATERIALS AND METHODS

This paper adopts a doctrinal legal research method. It examines constitutional provisions, statutes, administrative issuances, Supreme Court decisions, and local implementation instruments to determine the legal basis, scope, nature, and operational implications of the environmental governance obligations of local government units (LGUs) in the Philippines. The inquiry is primarily normative and interpretive. It asks what the law requires of LGUs, how those obligations are structured, how the Supreme Court has interpreted them, and how LGUs may operationalize them through local governance tools.

The analysis proceeds from the hierarchy and interaction of legal sources. First, it examines the 1987 Constitution, particularly the provisions on the right to a balanced and healthful ecology, the right to health, natural-resource stewardship, the social function of property, public participation, access to information, local autonomy, decentralization, fiscal authority, inter-LGU cooperation, and accountability of public officers. Article II, Section 16 provides the substantive environmental mandate, while Article X supplies the constitutional institutional basis for localizing that mandate through autonomous and accountable local governments.

Second, the paper analyzes the Local Government Code of 1991, particularly the provisions on ecological balance, the General Welfare Clause, devolved basic services and facilities, land-use regulation, consultation, inter-LGU cooperation, local legislation, barangay-level enforcement, and the functions of the Local Environment and Natural Resources Officer. The Code is treated as the principal statutory bridge between the Constitution's environmental mandate and the operational powers of LGUs.

Third, the paper examines major environmental statutes that particularize LGU responsibilities. These include the Philippine Environmental Policy, the Philippine Environment Code, the Environmental Impact Statement System, the Ecological Solid Waste Management Act, the Philippine Clean Water Act, the Philippine Clean Air Act, the Philippine Fisheries Code, the National Integrated Protected Areas System and Expanded NIPAS laws, the Climate Change Act, the Philippine Disaster Risk Reduction and Management Act, and the Seal of Good Local Governance Act. These laws are analyzed in relation to the Local Government Code to show how national environmental mandates are translated into local planning, regulation, service delivery, monitoring, and enforcement.

Fourth, the paper discusses relevant Supreme Court decisions that clarify the enforceability, scope, and limits of LGU environmental obligations. Particular attention is given to Oposa v. Factoran, Laguna Lake Development Authority v. Court of Appeals, Tano v. Socrates, Metropolitan Manila Development Authority v. Concerned Residents of Manila Bay, and Boracay Foundation, Inc. v. Province of Aklan. These cases are used not as isolated case digests, but as doctrinal authorities that explain the enforceability of environmental rights, the limits of local autonomy, the validity of local environmental regulation, the availability of mandamus to compel environmental duties, and the need to integrate environmental compliance into local development.

Fifth, the paper identifies LGU implementation tools that give operational effect to constitutional and statutory environmental mandates. These include the Comprehensive Land Use Plan, zoning ordinance, Comprehensive Development Plan, Local Development Investment Program, Annual Investment Program, Solid Waste Management Plan, Climate and Disaster Risk Assessment, Local Climate Change Action Plan, Local Disaster Risk Reduction and Management Plan, coastal resource management plans, fisheries ordinances, sanitation and septage programs, Environmental Compliance Certificate monitoring, local permits, local environmental codes, environmental fees, local boards, and enforcement mechanisms.

The scope of the paper is doctrinal rather than empirical. It does not measure the actual environmental performance of particular LGUs, nor does it conduct field assessment, compliance auditing, or case-study evaluation. Its purpose is to establish the legal framework governing LGU environmental obligations and to synthesize that framework into a coherent doctrine of devolved ecological responsibility.

The paper treats administrative issuances and planning guidelines as supplementary implementation instruments. DENR, EMB, DHSUD, former HLURB, and DILG issuances are relevant insofar as they operationalize constitutional, statutory, and jurisprudential mandates. However, the primary legal basis of LGU environmental governance remains the Constitution, the Local Government Code, environmental statutes, and Supreme Court jurisprudence.

RESULTS AND DISCUSSION

Doctrinal Synthesis: **LGUs as Frontline Institutions of Devolved Ecological Responsibility**

The constitutional, statutory, jurisprudential, and operational materials examined in the preceding sections converge on a single doctrinal proposition: LGUs are frontline institutions of devolved ecological responsibility. Their environmental role is not incidental to local governance. It is embedded in the constitutional structure, particularized by statute, interpreted by jurisprudence, and operationalized through local planning, regulatory, fiscal, monitoring, and enforcement instruments.

This doctrine may be stated as follows:

LGU environmental governance is a system of devolved ecological responsibility. The Constitution establishes the right to a balanced and healthful ecology and imposes upon the State the duty to protect and advance that right. Article X supplies the institutional basis for localizing this duty through local autonomy, decentralization, fiscal authority, inter-LGU cooperation, and accountable local governance. The Local Government Code operationalizes this constitutional structure by granting LGUs police power, devolved service functions, ordinance-making authority, consultation powers, intergovernmental cooperation mechanisms, and local environmental administration. Sectoral environmental laws particularize LGU obligations in solid waste management, water quality, air quality, fisheries, protected areas, climate change, disaster risk reduction, and environmental impact assessment. Supreme Court decisions interpret these mandates as legally enforceable obligations. LGU implementation tools then translate these mandates into plans, ordinances, permits, budgets, monitoring systems, and enforcement actions.

A. LGUs as Constitutional Duty-Bearers

The starting point is Article II, Section 16 of the 1987 Constitution, which provides that the State shall protect and advance the right of the people to a balanced and healthful ecology. This constitutional duty extends to LGUs because they are political subdivisions of the State. When the Local Government Code and environmental statutes assign environmental functions to LGUs, those functions must be understood as local expressions of the State's constitutional environmental obligation.

Article X strengthens the constitutional basis of LGU environmental governance. It supplies the institutional mechanism through which the environmental mandate of Article II, Section 16 is localized. Through local autonomy, decentralization, fiscal authority, inter-LGU cooperation, and accountable local governance, Article X enables LGUs to translate national environmental obligations into local plans, ordinances, permits, budgets, monitoring systems, and enforcement actions.

This means that LGU environmental governance is not merely a matter of policy preference. It is a constitutional responsibility carried out at the local level. An LGU that regulates land use, controls waste, protects municipal waters, manages drainage, enforces sanitation rules, or monitors development projects performs part of the State's duty to protect ecological balance.

The constitutional right to health, the social function of property, the State's stewardship of natural resources, the protection of subsistence fisherfolk, the right to information, public participation, and the accountability of public officers all reinforce this conclusion. Environmental governance by LGUs is therefore not based on a single constitutional clause alone; it arises from a wider constitutional framework of ecological protection, public welfare, participation, decentralization, and accountability.

B. LGUs as Statutory Implementers

The Local Government Code provides the principal statutory bridge between constitutional environmental policy and local implementation. Section 3(i) expressly provides that LGUs shall share with the national government responsibility for the management and maintenance of ecological balance within their territorial jurisdiction. Section 16, the General Welfare Clause, empowers LGUs to promote health and safety and enhance the people's right to a balanced ecology. Section 17 devolves basic environmental services, including sanitation, solid waste, water supply, drainage, sewerage, flood control, environmental management systems, fishery services, mangrove-related functions, and community forestry.

These provisions show that LGUs are not merely administrative adjuncts of national agencies. They are statutory implementers with direct responsibility over environmental conditions within their territorial jurisdiction. Their role is particularly visible in solid waste management under R.A. No. 9003, water quality management under R.A. No. 9275, air quality management under R.A. No. 8749, municipal fisheries under R.A. No. 8550 as amended, climate adaptation under R.A. No. 9729 as amended, and disaster risk reduction under R.A. No. 10121.

However, LGU authority is not absolute. The same statutory framework that empowers LGUs also subjects them to national environmental laws, standards, and regulatory agencies. Thus, LGUs implement environmental mandates within a system of shared governance: national agencies define standards and regulatory frameworks, while LGUs localize implementation through planning, ordinances, permits, services, monitoring, enforcement, budgeting, and coordination.

C. LGUs as Local Environmental Regulators

LGUs exercise environmental governance through their police power, particularly under the General Welfare Clause. This authority permits them to regulate private conduct in the interest of health, safety, public welfare, and ecological balance. It supports zoning ordinances, environmental codes, fisheries ordinances, nuisance abatement, sanitation rules, solid waste ordinances, business permit conditions, coastal regulations, and local restrictions against environmentally harmful activities.

The Supreme Court's ruling in Tano v. Socrates affirms this affirmative regulatory authority. The Court sustained local ordinances protecting fishery and aquatic resources, thereby recognizing that LGUs may validly restrict private activity when necessary to protect ecological resources and public welfare (Tano v. Socrates, G.R. No. 110249, August 21, 1997).

This regulatory function is crucial because many environmental harms arise from local activities: illegal dumping, untreated wastewater discharge, incompatible land uses, destructive fishing, mangrove cutting, foreshore encroachment, open burning, quarrying, tourism overdevelopment, and nuisance establishments. LGUs are often the first governmental institutions capable of detecting and regulating these activities. The legal doctrine therefore supports active, not passive, local environmental governance.

D. LGUs as Environmental Service Providers

LGUs are not only regulators; they are also service providers. Section 17 of the Local Government Code devolves basic services and facilities that directly affect environmental quality. These include solid waste collection and disposal, sanitation, drainage, sewerage, flood control, water supply, seawalls, environmental management systems, parks, and local infrastructure.

This service-delivery function distinguishes LGU environmental governance from purely regulatory environmental law. In many cases, environmental degradation results not only from private violations but also from weak public service systems. Poor solid waste collection, absence of septage management, clogged drainage, lack of wastewater facilities, inadequate flood control, and poorly planned settlements may all produce environmental harm.

The implication is that LGU environmental accountability may arise from both regulatory failure and service-delivery failure. Regulatory failure occurs when an LGU does not enforce ordinances, permits, zoning rules, sanitation standards, or fishery regulations. Service-delivery failure occurs when an LGU fails to provide or maintain legally required

environmental services, such as solid waste management, drainage, sewerage, sanitation, or local environmental management systems.

This distinction is important because it clarifies that LGU environmental responsibility is not limited to enforcement against private actors. It also includes the LGU's own duty to deliver environmental services.

E. LGUs as Environmental Planners

Environmental governance is also a planning function. The CLUP, zoning ordinance, CDP, LDIP, AIP, SWMP, CDRA, LCCAP, LDRRMP, coastal resource management plan, fisheries plan, sanitation and septage plan, and sustainable tourism plan are not merely administrative documents. They are legal-operational instruments through which the LGU gives life to constitutional and statutory mandates.

The planning function is preventive. It allows LGUs to avoid environmental harm before it occurs. Through the CLUP and zoning ordinance, an LGU may restrict development in hazard-prone or ecologically sensitive areas. Through the CDRA, it may identify climate and disaster risks. Through the SWMP, it may establish a system for waste segregation, collection, recovery, and disposal. Through the LCCAP and LDRRMP, it may integrate resilience into local development. Through coastal and fisheries plans, it may protect municipal waters, mangroves, coral reefs, seagrass beds, fish sanctuaries, and fisherfolk livelihoods.

This preventive dimension is central to environmental law. It is insufficient for an LGU to act only after pollution, flooding, coastal degradation, or resource depletion has already occurred. The mandate to protect ecological balance requires anticipation, planning, regulation, and prevention.

F. LGUs as Enforcement Partners

LGUs are also enforcement partners in the national environmental governance system. They enforce local ordinances, inspect establishments, monitor waste and wastewater conditions, regulate permits, support ECC compliance monitoring, participate in local boards, coordinate with national agencies, and refer violations to competent authorities.

This enforcement function is reinforced by Metropolitan Manila Development Authority v. Concerned Residents of Manila Bay, where the Supreme Court treated statutory environmental duties as enforceable obligations that may be compelled by mandamus (Metropolitan Manila Development Authority v. Concerned Residents of Manila Bay, G.R. Nos. 171947–48, December 18, 2008). The case is important because it rejects the view that environmental duties are merely discretionary or aspirational. Where the law imposes a clear duty, the responsible public institution may be compelled to perform it.

For LGUs, this means that the failure to enforce solid waste, sanitation, drainage, water quality, business permit, zoning, fisheries, or environmental ordinance requirements may become legally significant. The LGU need not be the sole cause of environmental harm before accountability may arise. It is enough that the law assigned a function to the LGU and the LGU failed, refused, or unreasonably delayed performance.

G. Local Autonomy as Power and Accountability

Local autonomy is often understood as protection against excessive national interference. In environmental governance, however, local autonomy has a dual character. It is both a source of authority and a basis of accountability.

As a source of authority, local autonomy allows LGUs to adopt place-specific environmental responses. A coastal municipality may regulate municipal waters, tourism density, mangrove protection, and fishery activity. An upland municipality may regulate slope development, forest use, quarrying, and watershed protection. A highly urbanized city may regulate drainage, air pollution, waste facilities, traffic emissions, and nuisance establishments.

As a basis of accountability, local autonomy prevents LGUs from claiming that environmental protection is solely the responsibility of national agencies. Where the law devolves functions to LGUs, local officials cannot evade responsibility by pointing only to the DENR, BFAR, DILG, DOH, DHSUD, EMB, or other national agencies.

At the same time, Laguna Lake Development Authority v. Court of Appeals clarifies that local autonomy does not authorize LGUs to disregard national environmental law or special environmental regulation (Laguna Lake Development Authority v. Court of Appeals, G.R. No. 110120, March 16, 1994). Local autonomy empowers LGUs to protect the environment, but it does not give them authority to pollute, approve unlawful land uses, operate non-compliant waste facilities, or ignore national environmental standards.

Thus, the proper doctrine is not local autonomy versus environmental regulation. Rather, it is local autonomy in service of environmental regulation.

H. The Legal Character of LGU Environmental Accountability

LGU environmental accountability should be carefully defined. It does not mean that an LGU is automatically liable for every environmental harm occurring within its territorial jurisdiction. Environmental degradation may be caused by private actors, national agencies, regional bodies, neighboring LGUs, historical land-use patterns, or transboundary ecological processes.

However, an LGU may be held accountable where four elements are present.

First, there must be a clear legal duty imposed by the Constitution, the Local Government Code, an environmental statute, an ordinance, a permit condition, or a court order.

Second, the LGU must have authority or capacity to act, whether through planning, regulation, permitting, service delivery, inspection, enforcement, budgeting, coordination, or referral.

Third, there must be failure, refusal, neglect, or unreasonable delay in performing the duty.

Fourth, there must be environmental harm, continuing degradation, or legally cognizable environmental risk connected to the non-performance of the duty.

This framework avoids overextension of LGU liability while preserving legal accountability. LGUs are not insurers of ecological perfection. But they are duty-bearing public institutions whose inaction may become legally actionable when the law imposes specific environmental responsibilities.

I. Devolved Ecological Responsibility as the Governing Doctrine

The doctrine of devolved ecological responsibility captures the legal position of LGUs in Philippine environmental governance.

It has four dimensions.

First, it is constitutional because it arises from the State's duty to protect and advance the right to a balanced and healthful ecology, and from Article X's institutional structure of local autonomy, decentralization, fiscal authority, inter-LGU cooperation, and accountable local governance.

Second, it is statutory because the Local Government Code and environmental laws assign concrete powers and duties to LGUs.

Third, it is jurisprudential because Supreme Court decisions interpret environmental rights and duties as legally meaningful and, in proper cases, enforceable.

Fourth, it is operational because LGUs possess implementation tools—plans, ordinances, permits, budgets, boards, monitoring systems, and enforcement units—through which environmental mandates may be carried out.

This doctrine best explains the relationship between LGUs and environmental law. LGUs are not merely local political units with incidental environmental functions. They are mandated local institutions of ecological governance.

VIII. Implications for Local Environmental Governance

The doctrine of devolved ecological responsibility has concrete implications for how LGUs should exercise their powers. If LGUs are constitutional duty-bearers, statutory implementers, local regulators, service providers, planners, enforcement partners, and accountability-bearing institutions, then environmental governance cannot be treated as an optional program. It must be embedded in local planning, budgeting, permitting, monitoring, and enforcement.

A. LGUs Must Treat Environmental Governance as a Core Mandate

The first implication is that environmental governance should be treated as a core local government mandate, not as a peripheral function. The Local Government Code expressly links LGU powers to the promotion of health and safety and the enhancement of the people's right to a balanced ecology (R.A. No. 7160, sec. 16). It also devolves basic services and facilities directly related to sanitation, waste management, drainage, sewerage, water supply, environmental management, fisheries, and community-based resource protection (R.A. No. 7160, sec. 17).

This means that an LGU cannot treat environmental protection as merely dependent on the availability of special projects, external grants, or national government intervention. While national agencies retain important regulatory and supervisory functions, the LGU has its own legal mandate. Environmental governance must therefore be integrated into the regular functions of the mayor or

governor, sanggunian, planning office, ENRO where applicable, health office, engineering office, agriculture office, tourism office, disaster risk reduction office, treasurer's office, assessor's office, and barangays.

The implication is organizational. Environmental governance should not be confined to isolated clean-up drives or occasional compliance reports. It should be mainstreamed across the local bureaucracy.

B. LGUs Must Harmonize Their Planning Instruments

The second implication is that LGUs must harmonize their planning instruments. The CLUP, zoning ordinance, CDP, LDIP, AIP, SWMP, CDRA, LCCAP, LDRRMP, coastal resource management plan, fisheries plan, sanitation or septage plan, and tourism development plan should not be prepared or implemented in isolation.

The CLUP determines spatial allocation. The zoning ordinance gives the CLUP regulatory force. The CDP identifies sectoral development priorities. The LDIP and AIP translate those priorities into funded programs and projects. The CDRA identifies hazards and climate risks. The LCCAP and LDRRMP provide adaptation, mitigation, prevention, preparedness, response, and recovery measures. The SWMP operationalizes solid waste management. Coastal, fisheries, sanitation, septage, and tourism plans address sector-specific environmental concerns.

If these instruments are inconsistent, the LGU's environmental governance system becomes fragmented. For example, a CLUP may designate a coastal area as environmentally constrained, while a tourism plan may promote intensive resort development in the same area. A CDRA may identify a flood-prone zone, while the zoning ordinance may still allow dense residential or commercial development. An SWMP may require materials recovery facilities, while the AIP may not allocate funding for them. Such inconsistencies weaken legal compliance and expose the LGU to governance failure.

The practical implication is that environmental planning must be integrated. The CLUP should be the spatial anchor; the zoning ordinance should be the regulatory instrument; the CDP, LDIP, and AIP should be the programming and budgeting instruments; and the sectoral environmental plans should be harmonized with all of them.

C. LGUs Must Integrate Environmental Compliance Into Local Permitting

The third implication concerns permitting. Local permits are among the strongest environmental governance tools available to LGUs. Locational clearances, zoning clearances, development permits, building permits, occupancy permits, business permits, sanitary permits, fishery licenses, tourism-related permits, and other local authorizations should not be treated as purely administrative documents. They are legal instruments for ensuring compliance with land-use, sanitation, safety, environmental, and public welfare standards.

This is particularly important in relation to the Environmental Compliance Certificate. The ECC is issued by DENR-EMB under the EIS System, not by the LGU. However, the LGU should use the ECC in local permitting and monitoring where applicable. A project proponent should not be allowed to use local permits to bypass or dilute ECC requirements. Where a project is covered by the EIS System, the LGU should require proof of ECC or Certificate of Non-Coverage before issuing local permits, subject to applicable rules.

The LGU should also ensure that local permits are consistent with the CLUP, zoning ordinance, sanitary requirements, building regulations, drainage standards, solid waste rules, water quality requirements, and applicable ECC conditions. Where an ECC condition requires wastewater treatment, drainage control, environmental monitoring, buffer zones, solid waste systems, or community safeguards, the LGU should consider these requirements in local permit review and monitoring, within the scope of its legal authority.

The doctrinal implication is that local permitting is not merely a revenue-generating function. It is a legal mechanism for implementing environmental governance.

D. LGUs Must Treat Environmental Duties as Continuing Obligations

The fourth implication is that LGU environmental duties are continuing obligations. Solid waste management, water quality protection, sanitation, drainage, sewerage, air quality management, fisheries regulation, coastal resource management, disaster risk reduction, and climate adaptation cannot be discharged through one-time acts.

R.A. No. 9003 requires continuing systems for segregation, collection, recovery, recycling,

composting, disposal, public education, and enforcement. R.A. No. 9275 requires continuing measures for water quality management, pollution control, sewerage, septage, and coordination. The Fisheries Code requires continuing regulation and conservation of municipal waters. The Climate Change Act and DRRM Act require continuing planning, updating, preparedness, and risk reduction.

This point is reinforced by MMDA v. Concerned Residents of Manila Bay, where the Supreme Court treated environmental rehabilitation as a continuing obligation enforceable through mandamus. The case demonstrates that statutory environmental duties are not exhausted by isolated compliance efforts. Where degradation persists, the duty to act also persists.

Thus, an LGU cannot rely solely on episodic activities such as clean-up drives, tree planting events, coastal clean-ups, or information campaigns. These may support environmental governance, but they do not substitute for legally required systems, facilities, ordinances, inspections, monitoring, budgets, and enforcement.

E. LGUs Must Use Local Autonomy Affirmatively

The fifth implication concerns local autonomy. Local autonomy is not merely a shield against national interference. It is also a legal basis for affirmative environmental action.

Through local autonomy and the General Welfare Clause, LGUs may adopt ordinances and programs suited to local ecological conditions. A coastal municipality may regulate municipal waters, marine protected areas, mangroves, beach easements, tourism density, and fishery activities. An upland municipality may regulate watershed protection, slope development, forest use, and quarrying. An urban city may regulate drainage, waste facilities, air pollution, terminals, nuisance establishments, and land-use compatibility.

The doctrine in Tano v. Socrates supports this affirmative use of local police power. LGUs may validly regulate private economic activity when necessary to protect fisheries, aquatic resources, ecological balance, and public welfare.

However, local autonomy must be exercised within the limits of national law. Laguna Lake Development Authority v. Court of Appeals makes clear that local autonomy does not authorize LGUs to disregard special environmental regulation or national environmental standards. Therefore, LGUs should use local autonomy to strengthen environmental protection, not to justify non-compliance.

The proper view is this: local autonomy is authority in service of ecological protection.

F. LGUs Must Coordinate With National Agencies, Other LGUs, and Local Stakeholders

The sixth implication is coordination. Environmental systems do not follow political boundaries. Watersheds, rivers, coastal waters, airsheds, drainage systems, solid waste disposal systems, tourism corridors, protected areas, and fisheries ecosystems often cross municipal, city, provincial, or regional lines.

The Local Government Code recognizes this by authorizing inter-LGU cooperation and collaboration with NGOs and people's organizations (R.A. No. 7160, secs. 33, 35–36). Sections 26 and 27 also require consultation with LGUs and affected sectors for environmentally significant projects.

Coordination is necessary in at least five settings.

First, watershed and river-basin management often requires cooperation among upland and downstream LGUs.

Second, coastal and fisheries governance requires coordination among municipalities sharing bays, gulfs, straits, or contiguous municipal waters.

Third, solid waste management may require common sanitary landfills, clustered disposal systems, shared materials recovery facilities, or inter-LGU waste processing arrangements.

Fourth, tourism development often affects neighboring LGUs through transport, water demand, wastewater flows, solid waste generation, and coastal impacts.

Fifth, protected areas and environmentally critical areas require coordination among LGUs, DENR, PAMBs, local communities, indigenous peoples where applicable, and affected sectors.

The implication is that LGUs should not rely solely on territorial regulation. They should use inter-LGU agreements, joint ordinances, shared facilities, watershed councils, bay-wide management bodies, FARMCs, PAMBs, multipartite monitoring teams, and local development councils to address cross-boundary environmental problems.

G. LGUs Must Institutionalize Monitoring and Evidence-Based Enforcement

The seventh implication is that environmental governance requires monitoring. Plans and ordinances are insufficient without evidence, inspection, and enforcement.

An LGU should maintain data on waste generation, waste diversion, MRF performance, collection efficiency, illegal dumping, water quality, septic tank desludging, drainage conditions, flood-prone areas, coastal erosion, mangrove cover, fishery activity, tourism pressure, ECC-covered projects, business permit compliance, sanitary violations, and environmental complaints.

This data should inform local decision-making. For example, waste generation data should guide the SWMP and budget allocation. Water quality data should guide septage programs and enforcement against illegal discharge. Hazard data should guide zoning restrictions and relocation planning. Tourism pressure data should guide carrying capacity measures. Fisheries data should guide municipal water regulation.

Monitoring should also be linked with enforcement. Where violations are detected, the LGU should issue notices, conduct inspections, impose penalties where authorized, suspend or revoke permits where legally justified, refer matters to DENR-EMB or BFAR where appropriate, and document compliance action.

The implication is that environmental governance must become evidence-based. Without monitoring, an LGU cannot credibly claim compliance with its environmental mandate.

H. LGUs Must Provide Budgetary Support for Environmental Mandates

The eighth implication concerns finance. Environmental governance cannot be effective without budgetary support. Solid waste systems, septage programs, drainage improvement, coastal enforcement, water quality monitoring, urban greening, mangrove rehabilitation, disaster risk reduction, climate adaptation, and environmental inspections require recurring funds.

The LDIP, AIP, annual budget, development funds where lawfully applicable, LDRRM Fund, environmental fees, garbage fees, septage fees, tourism environmental fees, conservation fees, fishery license fees, and penalties may all support environmental governance, subject to legal limitations.

This budgetary implication is important because unfunded mandates often result in symbolic compliance. An LGU may have an SWMP but no funded MRF. It may have a CDRA but no risk-sensitive infrastructure program. It may have a coastal resource management plan but no Bantay Dagat support. It may have a septage ordinance but no treatment facility or desludging system. It may have a zoning ordinance but no enforcement personnel.

A doctrinally sound view of LGU environmental governance must therefore connect legal duty with fiscal implementation. Local environmental obligations should be reflected in investment programming and annual appropriations.

I. LGUs Must Respect Participation, Transparency, and Due Process

The ninth implication concerns participatory governance. The Constitution protects the people's right to information on matters of public concern and recognizes public participation in decision-making. The Local Government Code requires consultation for projects with significant ecological consequences. Environmental laws also include participatory mechanisms, such as FARMCs, PAMBs, local solid waste boards, local development councils, and multipartite monitoring arrangements.

LGUs should therefore ensure that environmental decisions are transparent and consultative. This applies to CLUP preparation, zoning amendments, establishment of waste facilities, coastal development, tourism projects, fishery regulation, resettlement from danger areas, protected-area management, and projects requiring ECCs.

Participation must also be meaningful. Public hearings should not be reduced to formal compliance. Affected communities, fisherfolk, indigenous peoples where applicable, farmers, women, youth, local businesses, tourism stakeholders, environmental groups, and barangays should have access to relevant information and a reasonable opportunity to be heard.

At the same time, enforcement must observe due process. Permit suspension, business closure, demolition, relocation, penalties, and nuisance abatement should follow applicable legal procedures. Environmental governance should be firm, but it must also be lawful.

J. LGUs Must Balance Development With Ecological Limits

The tenth implication is especially important for rapidly urbanizing and tourism-oriented LGUs. Local

economic development, including tourism, infrastructure, commerce, fisheries, agriculture, and investment promotion, must be pursued within ecological limits.

The Constitution does not prohibit development. The Local Government Code encourages local development. However, development must be compatible with ecological balance, public health, disaster risk reduction, natural-resource conservation, and intergenerational responsibility.

This means that LGUs should consider carrying capacity, water supply, wastewater capacity, solid waste capacity, drainage capacity, coastal stability, protected areas, fisherfolk access, agricultural land protection, disaster risk, and climate vulnerability before approving major development.

In tourism areas, this implication is particularly important. Tourism may generate local income, employment, infrastructure, and investment. However, unregulated tourism can also produce land conversion, water scarcity, sewage discharge, solid waste growth, beach congestion, coral reef damage, displacement of fisherfolk, mangrove loss, and increased disaster exposure. Therefore, tourism planning should be integrated with environmental governance.

An LGU that promotes tourism without corresponding controls over land use, wastewater, solid waste, carrying capacity, coastal setbacks, and ecological monitoring risks failing its environmental mandate.

K. LGU Inaction May Create Legal Accountability

The final implication is accountability. The paper's doctrinal framework shows that LGU environmental duties are not purely moral or political. They may carry legal consequences.

Accountability may arise in several ways.

First, judicial accountability may arise where a clear legal duty is enforceable through mandamus, continuing mandamus, injunction, writ of kalikasan, or other environmental remedies.

Second, administrative accountability may arise where local officials fail to perform duties imposed by law, ordinance, regulation, or lawful directive.

Third, statutory accountability may arise under specific environmental laws, such as R.A. No. 9003, R.A. No. 9275, or related statutes, where sanctions are provided.

Fourth, political accountability may arise through elections, public hearings, local legislative oversight, public disclosure, and community pressure.

Fifth, fiscal accountability may arise through audit findings where environmental funds, development funds, or disaster risk reduction funds are misused, underused, or not aligned with legally authorized purposes.

This does not mean that LGUs are automatically liable for every environmental problem within their jurisdiction. The more precise rule is that accountability may arise where there is a clear duty, capacity to act, failure or neglect, and resulting environmental harm or legally cognizable risk.

L. Summary of Governance Implications

The doctrine of devolved ecological responsibility requires LGUs to perform environmental governance as an integrated legal mandate. In practical terms, LGUs must mainstream environmental protection across local offices and functions, harmonize planning instruments, integrate ECC conditions and environmental laws into local permitting, treat environmental duties as continuing obligations, use local autonomy affirmatively for ecological protection, coordinate with national agencies and other stakeholders, institutionalize monitoring and evidence-based enforcement, provide budgetary support for environmental programs, respect participation and due process, balance development with ecological limits, and recognize that inaction may produce legal accountability.

These implications show that LGU environmental governance is not merely a legal theory. It is a practical framework for how local governments should plan, regulate, finance, monitor, and enforce environmental protection within their territorial jurisdictions.

Based on the foregoing doctrinal analysis, this paper reaches the central conclusion that environmental governance by local government units is not merely a matter of administrative discretion, local policy preference, or political convenience. It is a constitutional and statutory obligation. LGUs are legally situated at the operational front line of the State's duty to protect and advance the people's right to a balanced and healthful ecology. Their authority to act arises from the Constitution, is particularized by the Local Government Code and environmental statutes, is interpreted and enforced through Supreme Court jurisprudence, and is operationalized through

local planning, regulatory, fiscal, monitoring, and enforcement tools.

A. LGU Environmental Governance Is Constitutionally Grounded

The first conclusion is that LGU environmental governance has a constitutional foundation. Article II, Section 16 of the 1987 Constitution imposes upon the State the duty to protect and advance the right of the people to a balanced and healthful ecology. This duty is reinforced by the constitutional right to health, the State's stewardship over natural resources, the social function of property, the protection of public participation and access to information, the constitutional preference for subsistence fisherfolk in communal marine and fishing resources, and the principle that public office is a public trust (CONST., art. II, secs. 15, 16, 28; art. III, sec. 7; art. XI, sec. 1; art. XII, secs. 2, 6; art. XIII, secs. 7, 16).

Article X is especially significant because it supplies the institutional mechanism for localizing the environmental mandate. Through local autonomy, decentralization, fiscal authority, inter-LGU cooperation, and accountable local governance, Article X enables LGUs to translate national environmental obligations into local plans, ordinances, permits, budgets, monitoring systems, and enforcement actions (CONST., art. X, secs. 2, 3, 5–7, 13). Thus, the Constitution does not merely articulate an abstract environmental policy. It also creates the local governmental structure through which ecological protection may be implemented territorially and practically.

B. The Local Government Code Converts the Constitutional Mandate Into Local Powers and Duties

The second conclusion is that the Local Government Code of 1991 operationalizes the Constitution's environmental mandate. Section 3(i) expressly provides that LGUs share with the national government responsibility for the management and maintenance of ecological balance within their territorial jurisdiction. Section 16, the General Welfare Clause, authorizes LGUs to promote health and safety and enhance the people's right to a balanced ecology. Section 17 devolves basic services and facilities directly related to environmental governance, including sanitation, solid waste, water supply, drainage, sewerage, flood control, environmental management, fisheries, mangrove-related functions, community forestry, parks, and greenbelts. The Code further authorizes local legislative bodies to enact ordinances protecting the environment and penalizing acts that endanger ecological balance (R.A. No. 7160, secs. 3[i], 16, 17, 447, 458, 468).

These provisions demonstrate that LGUs are not merely passive consultees or administrative auxiliaries of national agencies. They are legal actors with their own environmental powers and responsibilities. They regulate land use, deliver environmental services, legislate local environmental rules, participate in consultations, cooperate with other LGUs and civil society, and maintain local environmental administration. The Local Government Code therefore serves as the statutory bridge between constitutional environmental rights and local environmental governance.

C. Sectoral Environmental Laws Particularize LGU Responsibilities

The third conclusion is that major environmental statutes particularize the general environmental powers of LGUs into specific sectoral duties. R.A. No. 9003 makes solid waste management a direct and continuing LGU responsibility. R.A. No. 9275 recognizes the role of LGUs in water quality management, sanitation, sewerage, septage, and pollution control. R.A. No. 8749 recognizes local participation in air quality management. R.A. No. 8550, as amended, places municipalities and cities at the center of municipal-water and fisheries governance. The EIS System, NIPAS and ENIPAS laws, the Climate Change Act, the DRRM Act, and the Seal of Good Local Governance Act further embed environmental protection in local planning, project approval, protected-area coordination, disaster-risk reduction, climate adaptation, and governance performance assessment.

The legal consequence is that LGU environmental governance is not a single undifferentiated duty. It is composed of multiple statutory functions: planning, regulation, service delivery, consultation, monitoring, enforcement, fiscal programming, coordination, and accountability. Each sectoral law gives content to what the constitutional right to a balanced and healthful ecology requires at the local level.

D. Supreme Court Jurisprudence Confirms That Environmental Duties Are Enforceable

The fourth conclusion is that Philippine jurisprudence confirms the legal enforceability of environmental duties. Oposa v. Factoran recognized the right to a balanced and healthful ecology as a legally

cognizable right and established the doctrine of intergenerational responsibility. Tano v. Socrates affirmed the authority of LGUs to enact ordinances protecting fisheries and aquatic resources. Laguna Lake Development Authority v. Court of Appeals clarified that local autonomy cannot be invoked to defeat special environmental regulation or national environmental standards. Metropolitan Manila Development Authority v. Concerned Residents of Manila Bay demonstrated that statutory environmental duties may be compelled by mandamus. Boracay Foundation, Inc. v. Province of Aklan reinforced the importance of environmental impact assessment, consultation, and compliance in local development.

Taken together, these cases establish that environmental governance is not merely aspirational. It is legally meaningful. The Constitution and statutes create rights, duties, standards, and institutional responsibilities that courts may recognize and, in proper cases, enforce. The jurisprudence also clarifies the dual character of LGU autonomy: it empowers LGUs to protect the environment, but it does not authorize them to disregard national environmental law.

E. Local Autonomy Is a Source of Environmental Authority and Accountability

The fifth conclusion is that local autonomy must be understood as both power and accountability. It gives LGUs authority to adopt place-specific environmental measures suited to local ecological conditions. A coastal municipality may regulate municipal waters, mangroves, marine protected areas, tourism pressure, and fishery activities. An upland municipality may regulate watersheds, forest use, quarrying, and slope development. An urban city may regulate drainage, waste facilities, transport-related emissions, nuisance establishments, and land-use compatibility.

However, local autonomy does not create environmental immunity. LGUs remain subject to the Constitution, national statutes, environmental standards, and lawful administrative supervision. Local autonomy cannot be used to justify non-compliant dumpsites, unlawful land uses, disregard of ECC requirements, failure to enforce sanitation standards, or tolerance of pollution. The proper doctrine is not local autonomy against environmental regulation, but local autonomy in service of environmental regulation.

F. LGUs Are Both Regulators and Service Providers

The sixth conclusion is that LGUs perform environmental governance in two major capacities: as regulators and as service providers. As regulators, they enact ordinances, issue permits, enforce zoning rules, regulate businesses, protect municipal waters, impose sanitation requirements, abate nuisances, and penalize environmentally harmful conduct. As service providers, they deliver or facilitate solid waste management, drainage, sewerage, sanitation, water supply, flood control, environmental management systems, parks, coastal protection, and related local infrastructure.

This distinction is important for accountability. LGU environmental failure may occur not only through non-enforcement against private actors, but also through failure to provide legally required environmental services. Weak solid waste systems, absent septage management, clogged drainage, non-functional materials recovery facilities, unregulated public markets, and poor sanitation infrastructure are not merely operational deficiencies. In proper cases, they may reflect failure to perform statutory environmental duties.

G. LGU Environmental Governance Is Preventive, Continuing, and Integrated

The seventh conclusion is that LGU environmental governance must be preventive, continuing, and integrated. It is preventive because LGUs must use planning, zoning, CDRA, LCCAP, LDRRMP, CLUPs, and sectoral plans to avoid foreseeable environmental harm before it occurs. It is continuing because statutory duties in solid waste, water quality, sanitation, drainage, fisheries, disaster risk reduction, and climate adaptation cannot be discharged through one-time activities. It is integrated because environmental governance cannot be fragmented among isolated offices, plans, permits, and projects.

This means that clean-up drives, tree planting events, coastal clean-ups, and information campaigns, while useful, are not substitutes for legally required systems. The LGU must maintain functioning plans, ordinances, budgets, facilities, monitoring systems, enforcement protocols, and intergovernmental coordination mechanisms. Environmental governance is not an episodic activity; it is a continuing structure of local public administration.

H. LGU Implementation Tools Give Operational Effect to Environmental Mandates

The eighth conclusion is that LGUs possess concrete tools to give life to environmental law. The CLUP and zoning ordinance convert ecological protection into spatial regulation. The CDP, LDIP, and AIP translate environmental priorities into funded programs. The SWMP operationalizes solid waste management. The CDRA, LCCAP, and LDRRMP integrate climate and disaster risk into local planning. Fisheries ordinances, coastal resource management plans, MPA plans, sanitation and septage plans, watershed plans, and sustainable tourism plans address sector-specific environmental concerns.

The ECC, although issued by DENR-EMB, becomes relevant to local permitting and monitoring where a project is located within the LGU's territory. Business permits, sanitary permits, development permits, building permits, locational clearances, zoning clearances, and fishery licenses allow LGUs to condition and monitor environmentally significant activities. Environmental fees, local boards, ENRO inspections, barangay enforcement, Bantay Dagat, Bantay Gubat, complaint mechanisms, and local environmental codes further support implementation.

The existence of these tools strengthens the accountability analysis. Where LGUs possess legal authority and operational instruments but fail to use them, environmental inaction becomes harder to justify.

I. LGU Accountability Must Be Carefully but Firmly Framed

The ninth conclusion is that LGU environmental accountability should be carefully framed. An LGU should not be treated as automatically liable for every environmental harm within its territory. Environmental degradation may arise from private conduct, national agency decisions, neighboring jurisdictions, historical land-use patterns, transboundary ecological processes, or broader socio-economic pressures.

However, LGU accountability may arise where four elements are present: first, a clear legal duty exists; second, the LGU has authority or capacity to act; third, the LGU fails, refuses, neglects, or unreasonably delays performance; and fourth, environmental harm, continuing degradation, or legally cognizable environmental risk results or continues. This framework avoids both extremes: it rejects automatic territorial liability, but it also rejects institutional evasion where the law clearly assigns environmental functions to LGUs.

J. Environmental Governance Requires Fiscal and Institutional Capacity

The tenth conclusion is that environmental mandates must be supported by fiscal and institutional capacity. Environmental governance cannot be performed through legal declarations alone. Solid waste facilities, septage systems, drainage improvements, water quality monitoring, coastal enforcement, climate adaptation, disaster-risk reduction, urban greening, mangrove rehabilitation, and local inspections require personnel, equipment, data systems, facilities, and recurring funds.

Article X of the Constitution recognizes the fiscal dimension of local autonomy through local revenue authority, a just share in national taxes, and equitable shares in national wealth. The Local Government Code and environmental statutes must therefore be read together with local budgeting and investment programming. The LDIP, AIP, annual budget, local environmental fees, LDRRM Fund, and lawful development funds are not peripheral to environmental governance. They are instruments through which legal duties become implementable.

K. Development Must Be Governed by Ecological Limits

The eleventh conclusion is that local development must be pursued within ecological limits. The Constitution and the Local Government Code do not prohibit local development. However, development must be consistent with ecological balance, public health, disaster-risk reduction, natural-resource conservation, social equity, and intergenerational responsibility.

This point is especially important for tourism-oriented, coastal, and rapidly urbanizing LGUs. Tourism and investment may generate income, employment, and infrastructure, but they may also intensify land conversion, water demand, wastewater discharge, solid waste generation, coastal congestion, reef damage, fisherfolk displacement, mangrove loss, and disaster exposure. LGUs must therefore evaluate carrying capacity, water supply, wastewater capacity, drainage capacity, solid waste capacity, coastal stability, protected-area restrictions, fisherfolk access, and climate vulnerability before approving or promoting major development.

In this sense, sustainable development is not merely a policy slogan. It is a legal requirement implicit in the constitutional, statutory, and jurisprudential structure of environmental governance.

L. The Governing Doctrine Is Devolved Ecological Responsibility

The final and overarching conclusion is that LGU environmental governance is best understood through the doctrine of devolved ecological responsibility. This doctrine has four dimensions.

First, it is constitutional because it arises from the State's duty to protect and advance the right to a balanced and healthful ecology and from Article X's system of local autonomy, decentralization, fiscal authority, and inter-LGU cooperation.

Second, it is statutory because the Local Government Code and environmental statutes assign concrete powers and duties to LGUs.

Third, it is jurisprudential because Supreme Court decisions recognize environmental rights, validate local environmental regulation, limit misuse of local autonomy, and permit judicial compulsion of statutory environmental duties.

Fourth, it is operational because LGUs possess implementation tools through which environmental mandates may be translated into plans, ordinances, permits, budgets, monitoring systems, enforcement units, and local institutions.

Accordingly, LGUs are not merely local political units with incidental environmental functions. They are mandated institutions of ecological governance. Their proximity to land use, waste generation, water pollution, drainage, sanitation, municipal waters, coastal settlements, tourism activities, local businesses, and community-level enforcement makes their role indispensable. The protection of the constitutional right to a balanced and healthful ecology depends not only on national environmental agencies, but also on the capacity, willingness, and legal accountability of LGUs to perform their environmental mandates.

In the final analysis, environmental governance by LGUs is not discretionary local programming. It is a constitutional, statutory, jurisprudential, and operational duty. Local autonomy is therefore not a basis for environmental inaction. It is the legal foundation for affirmative, accountable, and sustained local action in the protection of ecological balance.

Working Authorities

A. Constitutional Provisions

1987 Philippine Constitution, Preamble.

1987 Philippine Constitution, Article II, Section 15 — right to health.

1987 Philippine Constitution, Article II, Section 16 — right to a balanced and healthful ecology.

1987 Philippine Constitution, Article II, Section 22 — rights of indigenous cultural communities.

1987 Philippine Constitution, Article II, Section 28 — policy of full public disclosure.

1987 Philippine Constitution, Article III, Section 7 — right to information on matters of public concern.

1987 Philippine Constitution, Article X—local government, local autonomy, decentralization, fiscal authority, and inter-LGU cooperation.

1987 Philippine Constitution, Article XI, Section 1 — public office as a public trust.

1987 Philippine Constitution, Article XII, Section 2 —State ownership and control of natural resources.

1987 Philippine Constitution, Article XII, Section 3 —classification of lands of the public domain; conservation, ecology, and development.

1987 Philippine Constitution, Article XII, Section 4 —forest lands and national parks.

1987 Philippine Constitution, Article XII, Section 5 —ancestral lands of indigenous cultural communities.

1987 Philippine Constitution, Article XII, Section 6 —social function of property.

1987 Philippine Constitution, Article XIII, Sections 4, 6, and 7—agrarian reform, stewardship of natural resources, and preferential use of communal marine and fishing resources by subsistence fishermen.

1987 Philippine Constitution, Article XIII, Sections 15 and 16—people's organizations and public participation.

B. Statutes and Decrees

Presidential Decree No. 1151, Philippine Environmental Policy.

Presidential Decree No. 1152, Philippine Environment Code.

Presidential Decree No. 1586, Establishing an Environmental Impact Statement System, Including Other Environmental Management Related Measures and for Other Purposes.

Presidential Decree No. 705, Revised Forestry Code of the Philippines, as amended.

Republic Act No. 7160, Local Government Code of 1991.

Republic Act No. 7586, National Integrated Protected Areas System Act of 1992, as amended by Republic Act No. 11038.

Republic Act No. 8550, Philippine Fisheries Code of 1998, as amended by Republic Act No. 10654.

Republic Act No. 8749, Philippine Clean Air Act of 1999.

Republic Act No. 9003, Ecological Solid Waste Management Act of 2000.

Republic Act No. 9275, Philippine Clean Water Act of 2004.

Republic Act No. 9729, Climate Change Act of 2009, as amended by Republic Act No. 10174.

Republic Act No. 10121, Philippine Disaster Risk Reduction and Management Act of 2010.

Republic Act No. 11292, Seal of Good Local Governance Act of 2019.

C. Supreme Court Decisions

Oposa v. Factoran, G.R. No. 101083, July 30, 1993.

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D. Procedural Environmental Remedy

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E. Administrative Issuance

DENR Administrative Order No. 2003-30, Implementing Rules and Regulations of Presidential Decree No. 1586, Establishing the Philippine Environmental Impact Statement System.

CONCLUSION

The study concludes that local government units play a central and legally significant role in environmental governance in the Philippines. Their responsibility is not limited to assisting national government agencies, since the Constitution, the Local Government Code, environmental statutes, and Supreme Court decisions clearly recognize their authority and obligation to protect ecological balance within their respective jurisdictions. As frontline institutions, LGUs are expected to perform environmental duties through local planning, legislation, permitting, budgeting, monitoring, service delivery, and enforcement.

The paper further concludes that local autonomy should be understood not only as a source of power, but also as a basis of accountability. LGUs have the authority to create local environmental policies and programs that respond to the specific needs of their communities, but this authority must always be exercised in accordance with national environmental laws and standards. Therefore, environmental governance at the local level is a continuing legal duty that requires active, coordinated, and sustained action.

Overall, the research establishes the doctrine of devolved ecological responsibility, which means that LGUs are constitutionally grounded, statutorily empowered, judicially accountable, and operationally equipped to protect the environment. The effective protection of the people's right to a balanced and healthful ecology depends not only on national agencies, but also on the willingness, capacity, and accountability of LGUs to fulfill their environmental mandates.

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Projecting Rice Self-Sufficiency in the Philippines Through 2050: A Scenario-Based Analysis of Production, Land Use, and Regional Supply

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ABSTRACT

The Philippines stands out as both one of the world's largest rice producers and importers, presenting a significant challenge in feeding its growing population through 2050. This study explores the future of rice production, sufficiency, and resilience in the country by combining three analytical methods: (1) regional production trend analysis using Philippine Statistics Authority data from 2013 to 2025 across all 17 regions; (2) forecasting production, area harvested, and yield through 2050 using Holt's double exponential smoothing; and (3) assessing regional self-sufficiency under land conversion scenarios. Between 2013 and 2023, national palay production rose modestly from 18.44 million to 20.06 million metric tons, while the harvested area stayed steady at about 4.7 million hectares. Yield improvements from 3.89 to 4.17 MT/ha drove production gains. However, rice imports surged from 0.89 million MT in 2017 to an estimated 4.68 million MT in 2024, pushing the import dependency ratio to 28%, it's highest since 1988. Projections show production could reach 22.5 million MT by 2050, yet this falls short of the projected milled rice demand of 16.5 million MT, with a baseline production deficit of 2.4 million MT. Accounting for ongoing land conversion, this deficit could expand to 8 million MT, raising import dependency to 48%. Regionally, by 2050 only three of sixteen regions will remain self-sufficient, with Central Luzon traditionally the rice granary dropping below 100%, while eleven regions face deficits. Without major farming and land protection improvements, the Philippines will grow more import-dependent with less resilient food production.

Keywords: *Rice Sufficiency; Philippines; Exponential Smoothing; Food Security; Import Dependency; Land Conversion; Rice Tariffication Law; Production Forecast; Regional Self Sufficiency*

INTRODUCTION

Rice (Oryza sativa) is the foundation of food security in the Philippines, constituting the primary source of dietary calories for over 112 million people and providing livelihoods for approximately 10 million Filipinos (PSA, 2024; Moya et al., 2015). The Philippines occupies a distinctive position in global rice dynamics: it is simultaneously one of the world's largest rice producers and one of its largest importers, a duality reflecting deep structural challenges in the national food system (Dawe, 2010; Balisacan & Fuwa, 2004). Within the ASEAN region, the Philippines faces competitive disadvantages relative to major exporters such as Vietnam and Thailand, where larger farm sizes, more extensive irrigation, and stronger institutional support enable lower per unit costs (Bordey et al., 2020).

The pursuit of rice self sufficiency has defined Philippine agricultural policy for over five decades. The Rice Tariffication Law (RTL, Republic Act No. 11203) of 2019 replaced quantitative import restrictions with tariffs and established the Rice Competitiveness Enhancement Fund (RCEF), but it also depressed farmgate prices by 10 to 15% (Cororaton, 2020; Clarete et al., 2021). In 2024, Executive Order No. 62 further reduced tariffs from 35% to 15%, prompting record imports (CPBRD,

2026). These policy shifts raise a fundamental question about the future trajectory of Philippine food security: given current production trends, population growth, and trade dynamics, what will the landscape of rice sufficiency look like through 2050, and what level of resilience will the food system possess against external shocks?

Food security encompasses four interrelated dimensions: availability, access, utilization, and stability (FAO, 2021). Philippine rice policy has overwhelmingly focused on availability through national production targets, while the spatial distribution of sufficiency across regions has received less analytical attention. As urbanization converts agricultural land in some regions while others expand rice area, the geography of domestic rice supply is shifting in ways that national aggregate statistics do not capture.

Despite growing literature on Philippine rice production, few studies have integrated regional trend analysis with forecasting models and distributional analysis to assess the future landscape. Bartelet et al. (2025) analyzed regional production stagnation using PSA data from 2013 to 2023 but did not incorporate forecasting. Taer (2025) traced the decline of rice lands but focused on national aggregates. While the IRRI household panel surveys (Moya et al., 2015) have tracked rice farming dynamics over five decades, they have not integrated production forecasting with sufficiency projections. The CPBRD (2026) documented the import surge following trade liberalization but did not connect import trends to farmer welfare.

This study addresses these gaps by: (1) analyzing regional palay production trends across all 17 administrative regions using PSA data from 2013 to 2025; (2) documenting rice import dependency dynamics from 2017 to 2024; (3) applying Holt's double exponential smoothing to forecast area, production, and yield through 2050; (4) projecting the national sufficiency gap under population growth scenarios; and (5) projecting regional self sufficiency ratios to identify which regions will function as food baskets and which will become structurally deficit under continued land conversion.

MATERIALS AND METHODS

Data Sources

This study uses secondary data from the Philippine Statistics Authority (PSA) and supplementary trade data from government and international sources. The PSA Palay Production Survey (PPS) data, accessed through PSA OpenSTAT (openstat.psa.gov.ph), covers all 17 administrative regions from 2013 to 2025. Variables include area harvested (total, irrigated, rainfed) in hectares, production volume (total, irrigated, rainfed) in metric tons, and derived yield per hectare. Rice trade data (import volumes, farmgate prices, retail prices) were obtained from PSA Foreign Trade Statistics and Supply Utilization Accounts, supplemented by CPBRD (2026) and USDA FAS (2025) for 2022 to 2024 import figures not yet available on OpenSTAT. Population data by region were sourced from the PSA Census of Population for census years 2010, 2015, 2020, and 2024.

Holt's Double Exponential Smoothing

Holt's linear trend method (Holt, 1957; Hyndman & Athanasopoulos, 2021) was applied to area harvested, production volume, and yield per hectare for each region and the national aggregate, generating forecasts from 2026 through 2050. The model comprises three equations:

Level: $L_t = \alpha Y_t + (1 - \alpha)(L_{t-1} + T_{t-1})$ Trend: $T_t = \beta(L_t - L_{t-1}) + (1 - \beta)T_{t-1}$ Forecast: $F_{t+h} = L_t + hT_t$

where L_t is the smoothed level, T_t is the trend, Y_t is the observed value, α is the data smoothing factor, β is the trend smoothing factor, and h is the forecast horizon. Parameters were optimized per region via grid search ($\alpha \in \{0.1, ..., 0.9\}$, $\beta \in \{0.1, ..., 0.5\}$) minimizing the Mean Squared Error. Initial level was set to the first observation; initial trend was estimated as the average slope: $T_1 = (Y_n - Y_1)$

$/ (n - 1)$. Forecasted area values were floor bounded at zero. It should be noted that the 25-year forecast horizon (2026 to 2050) substantially exceeds the 13-year data series (2013 to 2025), and prediction uncertainty widens considerably with increasing horizon. While analytical prediction intervals for Holt's method are available (Hyndman & Athanasopoulos, 2021, Ch. 8), the primary purpose of the forecasts in this study is to establish baseline trajectories against which land conversion scenarios are compared, rather than to generate precise point predictions. The 2050 forecasts should therefore be interpreted as trajectory indicators conditional on the continuation of recent trends, not as precise predictions. The scenario analysis (Section 3.5) provides the range of plausible outcomes.

Demand Projection and Sufficiency Gap

Projected rice demand was calculated as: Demand = Population × Per capita consumption. Population was projected from the 2024 census (112.73 million; PSA, 2024) at 0.8% annual growth (see Assumption 2, Section 2.6). Per capita rice consumption was set at 119 kg/year (PSA, 2022; see Assumption 1, Section 2.6). Milled rice production was derived by applying a 0.63 milling recovery rate to palay forecasts (see Assumption 3, Section 2.6). The sufficiency gap was computed as: Gap = Projected demand – Projected milled production.

Import Dependency Ratio

IDR = [Imports / (Domestic Production + Imports)] × 100, using milled rice equivalents. Import data covers 2017 to 2024 from PSA Foreign Trade Statistics, CPBRD (2026), and USDA FAS (2025).

Regional Self-Sufficiency Ratio

The regional self-sufficiency ratio (SSR) was computed for each of the 16 rice-producing regions as: SSR = (Regional milled rice production / Regional demand) x 100, where demand equals regional population multiplied by per capita consumption (119 kg/year). SSR values above 100% indicate surplus regions capable of supplying other areas through interregional transfers; values below 100% indicate deficit regions dependent on transfers or imports. Regional SSR was projected for 2025, 2035, and 2050 under Scenario 2 (2% annual land conversion), applying the same yield improvement trajectory and population growth rate used in the national projections.

Key Assumptions

The projections rest on several assumptions summarized in Table 7. The most consequential are noted here.

Per capita rice consumption (119 kg/year) and population growth (0.8% per year) are held constant, based on PSA (2022) and PSA (2024), respectively. Both have been declining historically, so holding them constant likely overestimates demand, making the sufficiency gap projections conservative. The

0.63 milling recovery rate follows the PSA and PhilRice standard for national accounting.

The land conversion scenarios apply uniform rates across all regions and assume yield continues improving regardless of which land is lost. In practice, conversion disproportionately affects irrigated, high-yield land near urban centers (Taer, 2025; Carating et al., 2014), meaning actual production losses may exceed the projections. Climate change impacts on yield are excluded (Peng et al., 2004; Stuecker et al., 2018), and no policy or technological disruptions are modeled. Both omissions bias the projections optimistically. The net effect is that four of seven assumptions make the projections more optimistic than the actual outcome is likely to be.

Table 7. Summary of key assumptions underlying the projections.

Assumption	Parameter Value	Source	Bias Direction	Net Effect on Gap
Constant per capita consumption	119 kg/yr	PSA (2022)	Overestimates demand	Conservative (gap may be smaller)
Constant population growth	0.8%/yr	PSA (2024)	Overestimates demand	Conservative (gap may be smaller)
Constant milling recovery	0.63	PSA/PhilRice standard	Neutral	Neutral
Uniform regional conversion	1%, 2%, or 4%/yr nationally	Taer (2025); Carating et al. (2014)	Mixed	Understates peri-urban loss
Yield unaffected by land type lost	Holt trend constant	Assumption	Understates production loss	Optimistic (gap may be larger)
No climate change impacts	None modeled	Peng et al. (2004); Stuecker et al. (2018)	Understates production loss	Optimistic (gap may be larger)
No policy/technology disruptions	Trend continuation	Standard limitation	Uncertain	Uncertain

Note: Assumptions 1 and 2 bias projections conservatively (overestimate the sufficiency gap). Assumptions 5 and 6 bias projections optimistically (underestimate the gap). The net direction of bias is uncertain, but the optimistic assumptions (5, 6) affect production directly, while conservative assumptions (1, 2) affect demand, which is the smaller component of the gap calculation.

RESULTS AND DISCUSSION

National Production Trends, 2013 to 2025

National palay production exhibited modest but uneven growth over the study period (Table 1). Production increased from 18.44 million MT in 2013 to a record 20.06 million MT in 2023, declined to 19.09 million MT in 2024, and partially recovered to 19.67 million MT in 2025. The 2013 to 2023 growth of 9% over a decade translates to an annualized rate of less than 1%, substantially below the population growth rate of approximately 1.5% over the same period.

Area harvested remained remarkably stable, fluctuating within a narrow band of 4.56 to 4.82 million hectares (Table 1). This stability contrasts with the documented contraction of the physical rice land inventory (as distinct from area harvested, which includes double cropped land) from 3.6 million hectares in 1980 to 1.9 million hectares by 2012

(PSA, 2022; CARRD, 2015), indicating that the major period of rice land conversion occurred before the study window. Production gains were driven entirely by yield improvements, from 3.89 MT/ha in 2013 to 4.17 MT/ha in 2023 (7.2% increase). National average yield remains approximately 44% below the achievable potential of 6 to 8 MT/ha (Bordey et al., 2020).

Table 1. National palay production, area harvested, yield, milled rice production, and rice imports, Philippines, 2013 to 2025.

Year	Area Harvested (ha)	Palay Production (MT)	Yiel (MT/	Milled Rice (MT)	Rice Imports (MT)	IDR (%)
2013	4,746,091	18,439,420	3.89	11,616,834	—	—
2014	4,739,672	18,967,826	4.00	11,949,730	—	—
2015	4,656,227	18,149,838	3.90	11,434,398	—	—
2016	4,556,043	17,627,245	3.87	11,105,164	—	—
2017	4,811,808	19,276,347	4.01	12,144,098	888,086	6.8
2018	4,800,406	19,066,094	3.97	12,011,639	2,006,349	14.3
2019	4,651,490	18,814,827	4.04	11,853,341	3,122,094	20.8
2020	4,718,896	19,294,856	4.09	12,155,759	2,226,122	15.5
2021	4,805,077	19,960,170	4.15	12,574,907	2,975,313	19.1
2022	4,804,591	19,756,513	4.11	12,446,603	3,788,000	23.3
2023	4,815,813	20,059,562	4.17	12,637,524	3,932,000	23.7
2024	4,645,921	19,087,135	4.11	12,024,895	4,680,000	28.0
2025	4,748,885	19,674,390	4.14	12,394,866	—	—

Note: *Source: PSA Palay Production Survey via OpenSTAT (area, production, yield); PSA Supply Utilization Accounts (milled rice); PSA Foreign Trade Statistics, CPBRD (2026), and USDA FAS (2025) for import volumes. IDR = Import Dependency Ratio = Imports/ (Milled Production + Imports) x 100. Milled rice computed at a 0.63 milling recovery rate where SUA data are unavailable. Import data for 2013-2016 not available in PSA dataset. 2022-2024 import volumes from CPBRD (2026) and USDA FAS (2025).*

Regional Production Asymmetries

Regional analysis reveals pronounced spatial concentration and divergent area trajectories (Table 2). In 2023, Central Luzon (3.64 million MT, 18.1%), Cagayan Valley (3.03 million MT, 15.1%), and Western Visayas (2.26 million MT, 11.3%) collectively produced 44.5% of national output. Adding the Ilocos Region (9.9%), the top four regions produced more than half the country's rice.

Yield varied substantially: Central Luzon recorded 5.25 MT/ha, while Central Visayas achieved only 3.00 MT/ha, a 75% differential reflecting differences in irrigation coverage, input access, and extension support. Area change from 2013 to 2025 was strikingly heterogeneous: Central Visayas lost 28.3%, CAR lost 25.1%, Western Visayas lost 23.5%, and Eastern Visayas lost 20.3%. Conversely, MIMAROPA grew 18.6%, BARMM 15.5%, and Northern Mindanao 12.0%. These expansions and contractions approximately offset each other at the national level, producing the observed aggregate stability.

Table 2. Palay production, area harvested, yield, and area change by region, Philippines, 2023 (ranked by production).

Region	Production 2023 (MT)	Area arvested 023 (ha)	eld 23 /ha)	Natio nal Share (%)	Area Change 2013-2025 (%)
Region III - Central Luzon	3,638,431	692,877	5.25	18.1	-3.3
Region II - Cagayan Valley	3,026,088	632,728	4.78	15.1	+5.4
Region VI - Western Visayas	2,263,158	666,296	3.40	11.3	-23.5
Region I – Ilocos	1,990,287	410,925	4.84	9.9	+1.5
Region V – Bicol	1,302,649	344,007	3.79	6.5	-0.6
Region XII – SOCCSKSARGEN	1,256,406	338,689	3.71	6.3	-3.6
Region IV-B – MIMAROPA	1,210,384	310,185	3.90	6.0	+18.6
BARMM	895,563	258,178	3.47	4.5	+15.5
Region VIII - Eastern Visayas	844,372	241,291	3.50	4.2	-20.3
Region X - Northern Mindanao	824,241	173,969	4.74	4.1	+12.0
Region IX - Zamboanga Peninsula	703,864	170,567	4.13	3.5	+7.7
Region XIII – Caraga	543,431	162,990	3.33	2.7	-6.3
Region XI – Davao	502,745	110,834	4.54	2.5	+7.9
Region IV-A – CALABARZON	433,399	108,320	4.00	2.2	-10.2
CAR	331,470	96,233	3.44	1.7	-25.1
Region VII - Central Visayas	293,073	97,724	3.00	1.5	-28.3
PHILIPPINES (Total)	**20,059,562**	**4,815,813**	**4.17**	**100.0**	**+0.1**

Note: *Source: PSA Palay Production Survey via OpenSTAT. Area change = (Area 2025 - Area 2013) / Area 2013 x 100. NCR excluded (negligible rice production). Red values indicate area contraction exceeding 10%; green indicates expansion exceeding 10%. The 2024 Negros Island Region reclassification (RA 12000) affects 2025 area figures for Western Visayas and Central Visayas.*

Rice Import Dependency

The Philippines' rice import trajectory underwent structural breaks following the RTL in 2019 and EO 62 in 2024 (Table 3). Pre-RTL imports under quantitative restrictions were 0.89 million MT in 2017 and 2.01 million MT in 2018. Post RTL, imports surged to 3.12 million MT in 2019 (+56%). After a COVID-19 moderation (2.23 million MT in 2020), imports rose continuously: 2.98 million MT (2021),

3.79 million MT (2022), 3.93 million MT (2023), and 4.68 million MT (2024). The 2024 figure represents the highest volume since 1988, driven by EO 62's

tariff reduction from 35% to 15% (CPBRD, 2026). The IDR rose from approximately 7% in 2017 to 28% in 2024.

Farmgate palay prices increased from PHP 16.53/kg in 2013 to PHP 20.06/kg in 2018, then declined sharply to PHP 16.95/kg in 2019 following RTL implementation, recovered partially post 2020, and surged to PHP 23.48/kg in 2024 amid global price increases. Retail regular milled rice prices followed a similar pattern, reaching PHP 50.41/kg in 2024. The farmgate to retail spread widened from PHP

23.31/kg in 2018 to PHP 26.93/kg in 2024, suggesting increased value capture by intermediaries.

Table 3. Rice import volume, farmgate and retail prices, and price spread, Philippines, 2013 to 2024.

Year	Rice Imports (MT)	Farmgate Price (PHP/kg)	Retail Price (PHP/kg)	ice read HP/kg)	Policy Context
2013	—	16.53	34.95	18.42	*Pre-RTL*
2014	—	19.46	39.76	20.30	*Pre-RTL*
2015	—	17.55	39.47	21.92	*Pre-RTL*
2016	—	17.76	39.02	21.26	*Pre-RTL*
2017	888,086	18.08	39.52	21.44	*Pre-RTL; QR regime*
2018	2,006,349	20.06	43.37	23.31	*Pre-RTL; QR regime*
2019	3,122,094	16.95	41.16	24.21	*RTL enacted (RA 11203)*
2020	2,226,122	16.76	39.05	22.29	*Post-RTL; COVID-19*
2021	2,975,313	16.76	38.28	21.52	*Post-RTL*
2022	3,788,000	17.44	39.15	21.71	*Post-RTL; global price rise*
2023	3,932,000	19.88	42.80	22.92	*Post-RTL; record production*
2024	4,680,000	23.48	50.41	26.93	*EO 62 (tariff 35% to 15%)*

Note: *Source: PSA Foreign Trade Statistics, CPBRD (2026), USDA FAS (2025) for imports. PSA OpenSTAT for farmgate and retail prices. Price spread = Retail price minus farmgate price. Import data unavailable for 2013-2016 from PSA dataset. RTL = Rice Tariffication Law; QR = Quantitative Restriction; EO 62 = Executive Order No. 62.*

Exponential Smoothing Forecasts to 2050

Holt's double exponential smoothing, with optimized parameters of $\alpha = 0.1$ and $\beta = 0.1$ for the national aggregates, projects the following trajectories (Table 4):

Area harvested is projected to remain virtually flat at approximately 4.74 million hectares through 2050, reflecting the offsetting regional dynamics (contractions in Visayas/peri urban areas balanced by Mindanao expansion). Production volume is projected to increase from 19.67 million MT in 2025 to approximately 20.28 million MT by 2030 and 22.46 million MT by 2050, driven solely by yield improvements. Yield is projected to grow from 4.14 MT/ha in 2025 to approximately 4.74 MT/ha by 2050, a 14.5% increase over 25 years.

Table 4. Holt's double exponential smoothing: National forecasts for selected years, 2025 to 2050.

Year	Area (M ha)	Palay (M MT)	ld T/ha)	Pop. (M)	emand M MT)	Suppl y (M MT)	nce (M	95% PI for Palay (M MT)
2025	4.75	19.67	4.14	112.73	13.41	12.39	-1.02	*Actual*
2030	4.74	20.28	4.28	117.30	13.96	12.78	-1.18	*18.7 to 21.8*
2035	4.74	20.82	4.40	122.08	14.53	13.12	-1.41	*19.0 to 22.7*
2040	4.74	21.37	4.51	127.05	15.12	13.46	-1.66	*19.3 to 23.5*
2045	4.74	21.91	4.63	132.23	15.74	13.80	-1.93	*19.6 to 24.2*
2050	4.74	22.46	4.74	137.63	16.38	14.15	-2.23	*19.9 to 25.0*

Note: *Source: 2025 values from PSA OpenSTAT. 2030-2050 values from Holt's exponential smoothing ($\alpha = 0.1$, $\beta = 0.1$). Population projected at 0.8% annual growth from 2024 base of 112.73M (PSA, 2024). Per capita consumption = 119 kg/year (PSA, 2022). Milled rice = palay x 0.63. Balance and rice balance = Milled production minus demand. Negative values indicate deficit (import requirement). More negative = larger shortfall. 95% PI = approximate 95% prediction interval for palay production, computed using the analytical formula for Holt's method (Hyndman & Athanasopoulos, 2021, Ch. 8) with residual standard error of 0.59 M MT estimated from the 2013-2025 series. Interval widths increase with forecast horizon, reflecting growing uncertainty.*

Production Scenarios Under Agricultural Land Conversion

The exponential smoothing baseline (Section 3.4) assumes no further loss of rice land, effectively projecting the current area plateau forward. However, Agricultural land conversion remains an active and well-documented process in the Philippines. Taer (2025) reported that approximately 97,593 hectares of farmland were converted to non-agricultural uses annually between 1988 and 2016, equivalent to approximately 2.1% of the current 4.74 million hectare base per year. In Central Luzon, the country's principal rice-producing region, Carating et al. (2014) documented conversion rates of 3 to 5% per year, with prime irrigated rice lands lost to residential subdivisions and industrial zones. Kajisa (2022) corroborated this trend, reporting that average farm sizes in Central Luzon declined from

2.54 hectares in 1970 to 1.79 hectares in 2020. The National Irrigation Administration (NIA) reported that 111,079 hectares of formerly irrigated land in Central Luzon alone were converted between 2012 and 2022 (German et al., 2024). A national-scale spatial analysis by Araza et al. (2026) found a strong

correlation (r = 0.89) between cropland loss and built-up expansion, with approximately 31% of converted cropland falling within legally protected zones, indicating weak enforcement of existing land use protections.

To assess the impact of continued land conversion on rice sufficiency, three scenarios were modeled, each applying a different annual area reduction rate to the 2025 base of 4.74 million hectares while holding the Holt yield forecast constant (Table 5, Figure 1). An important assumption underlying all three scenarios is that yield continues to improve at the forecast rate regardless of which land is converted. In practice, land conversion disproportionately affects irrigated, high-yield areas near urban centers (Taer, 2025; Carating et al., 2014), meaning that the scenarios may underestimate production losses if prime agricultural land is lost first. The projections should therefore be considered conservative (optimistic) estimates of production decline under land conversion.

Table 5. Rice sufficiency under three land conversion scenarios, Philippines, 2025 to 2050.

Scenario / Year	2025	2030	2035	2040	2045	2050
Baseline: No further land loss (0%/yr)						
Rice area remaining	4.74 M ha	4.74 M ha	4.74 M ha	4.74 M ha	4.74 M ha	4.74 M ha
Milled rice production	12.36 M MT	12.72 M MT	13.08 M MT	13.44 M MT	13.80 M MT	14.15 M MT
Rice demand	13.52 M MT	14.07 M MT	14.64 M MT	15.24 M MT	15.86 M MT	16.50 M MT
Rice balance	-1.16 M MT	-1.35 M MT	-1.56 M MT	-1.80 M MT	-2.06 M MT	-2.35 M MT
Import dependency ratio	8.6%	9.6%	10.7%	11.8%	13.0%	14.2%
Scenario 1: Conservative (1%/yr)						
Rice area remaining	4.74 M ha	4.51 M ha	4.29 M ha	4.08 M ha	3.88 M ha	3.69 M ha
Milled rice production	12.36 M MT	12.10 M MT	11.83 M MT	56 M MT	11.28 M MT	11.01 M MT
Rice demand	13.52 M MT	14.07 M MT	14.64 M MT	15.24 M MT	15.86 M MT	16.50 M MT
Rice balance	-1.16 M MT	-1.97 M MT	-2.81 M MT	-3.68 M MT	-4.57 M MT	-5.49 M MT
Import dependency ratio	8.6%	14.0%	19.2%	24.2%	28.8%	33.3%
Scenario 2: Historical rate (2%/yr; Taer, 2025)						
Rice area remaining	4.74 M ha	4.28 M ha	3.87 M ha	3.50 M ha	3.16 M ha	2.86 M ha
Milled rice production	12.36 M MT	11.50 M MT	10.69 M MT	9.92 M MT	9.21 M MT	8.54 M MT
Rice demand	13.52 M MT	14.07 M MT	14.64 M MT	15.24 M MT	15.86 M MT	16.50 M MT
Rice balance	-1.16 M MT	-2.57 M MT	-3.96 M MT	-5.31 M MT	-6.65 M MT	-7.96 M MT
Import dependency ratio	8.6%	18.3%	27.0%	34.9%	41.9%	48.2%
Scenario 3: Accelerated (4%/yr; Central Luzon rate)						
Rice area remaining	4.74 M ha	3.86 M ha	3.15 M ha	2.57 M ha	2.10 M ha	1.71 M ha
Milled rice production	12.36 M MT	10.37 M MT	8.70 M MT	7.28 M MT	6.10 M MT	5.10 M MT
Rice demand	13.52 M MT	14.07 M MT	14.64 M MT	15.24 M MT	15.86 M MT	16.50 M MT
Rice balance	-1.16 M MT	-3.70 M MT	-5.95 M MT	-7.95 M MT	-9.76 M MT	-11.40 M MT
Import dependency ratio	8.6%	26.3%	40.6%	52.2%	61.5%	69.1%

Note: *Source: Authors' projections. Area reduction applied annually to the 2025 base of 4.74 M ha. Yield follows the Holt forecast trend (4.14 to 4.74 MT/ha by 2050). Population projected at 0.8%/yr from 2024 base of 112.73 M (PSA, 2024). Per capita consumption = 119 kg/yr. Milled rice = palay x 0.63. Conversion rates: 1%/yr = conservative estimate for continued peri-urban encroachment; 2%/yr = national historical rate derived from Taer (2025), 97,593 ha/yr over 4.74 M ha; 4%/yr = midpoint of Carating et al. (2014) Central Luzon rate of 3 to 5%/yr.*

Scenario Outcomes and Projected Sufficiency Gaps

The three scenarios produce markedly divergent outcomes (Table 5). Under the baseline (no land loss), the sufficiency gap widens from 1.16 million MT in 2025 to 2.35 million MT by 2050, with the IDR reaching 14.2%. Under Scenario 1 (1% annual conversion), area declines to 3.69 million hectares by 2050, the gap nearly triples to 5.49 million MT, and the IDR reaches 33.3%. Under Scenario 2 (2% annual conversion), area contracts to 2.86 million hectares, milled production falls to 8.54 million MT, the gap reaches 7.96 million MT, and the IDR rises to 48.2%. Under Scenario 3 (4% annual conversion), area shrinks to 1.71 million hectares, and the gap widens to 11.40 million MT with an IDR of 69.1%.

Figure 1 illustrates this divergence against the historical production and import record from 1987 to 2050. Domestic milled production has been below demand since approximately 2005, with the gap filled entirely by imports (green bars). After 2025, the four scenario lines diverge progressively, with the gap between each production line and the demand line representing the minimum import volume required.

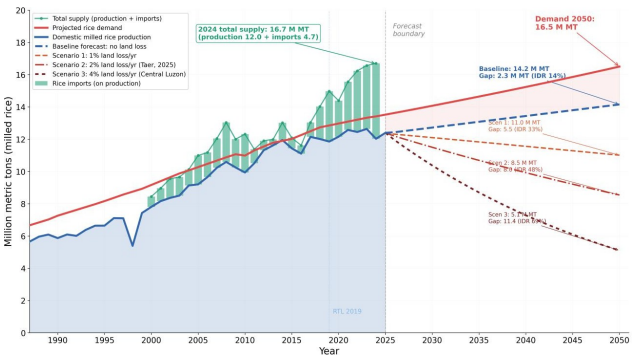

Figure 1. Milled rice production (blue), imports stacked on production (green), total supply (green line), and demand (red), Philippines, 1987 to 2050. Scenarios: baseline (0%), 1%, 2% (Taer, 2025), 4% (Carating et al.,

2014) annual land conversion. Source: PSA OpenSTAT; CPBRD (2026); USDA FAS (2025).

Figure 2 traces the historical trajectory of palay area harvested from 1987 to 2025, showing the expansion from 3.35 million hectares in 1987 to the 2013 to 2025 plateau at approximately 4.7 million hectares, with the 1998 El Niño dip to 3.17 million hectares visible. The three conversion scenario projections diverge after 2025, illustrating the range of potential area contraction.

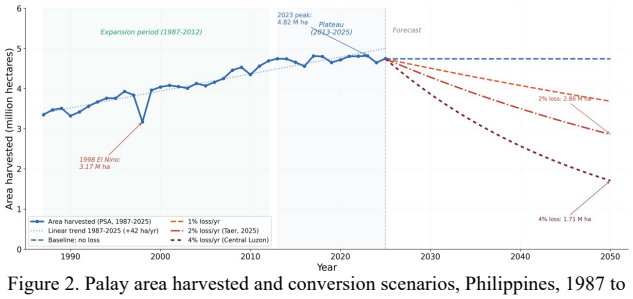

Figure 2. Palay area harvested and conversion scenarios, Philippines, 1987 to 2050. Solid blue: PSA (1987 to 2025). Dotted: linear trend (+42,300 ha/yr). Dashed: projected area under three conversion scenarios. Source: PSA OpenSTAT; CEIC.

Regional Self-Sufficiency Under Land Conversion

To assess the spatial distribution of rice sufficiency vulnerability, the self-sufficiency ratio (SSR) was computed for each region under Scenario 2 (2% annual land conversion) for 2025, 2035, and 2050. SSR is defined as the ratio of regional milled rice production to regional demand (population multiplied by per capita consumption of 119 kg/year), expressed as a percentage. An SSR above 100% indicates a surplus region capable of supplying other areas; an SSR below 100% indicates a deficit region dependent on interregional transfers or imports.

The analysis reveals a stark and widening spatial divide (Figure 3). In 2025, the Philippines has three major rice surplus regions: Cagayan Valley (SSR 434%), Ilocos (199%), and MIMAROPA (198%), which collectively function as the country's rice food baskets. Central Luzon (155%) and Western Visayas (151%) contribute additional surpluses that are transferred to deficit regions. At the other extreme, CALABARZON (SSR 14%) and Central Visayas (19%) are already in critical deficit, producing less than one-fifth of what they consume. The heavily urbanized CALABARZON region, home to 16.2 million people, is the most food insecure region in the country by this metric, dependent almost entirely on rice transfers from Central Luzon, Cagayan Valley, and imported supply.

By 2035, the number of surplus regions shrinks from five to four as Western Visayas declines to marginal status (SSR 122% to below the comfortable surplus threshold). Central Luzon, the traditional rice granary, drops to 122%, a level at which its surplus capacity is severely constrained. CAR (79%), Zamboanga (77%), Eastern Visayas (79%), and Northern Mindanao (69%) all fall below 80%, signaling that they can no longer reliably feed themselves from domestic production. Davao drops to 40%, entering severe deficit territory.

By 2050, only three regions retain SSR values above 100%: Cagayan Valley (242%), Ilocos (110%), and MIMAROPA (113%). Central Luzon falls to 85%, meaning the country's largest rice-producing region can no longer feed its own population. Eleven of sixteen regions are in deficit, with six in moderate deficit (SSR 50 to 75%), two in severe deficit (Davao 28%, Northern Mindanao 48%), and two in critical deficit (CALABARZON 8%, Central Visayas 11%). The entire food system becomes dependent on two to three surplus regions plus imports, creating extreme concentration risk.

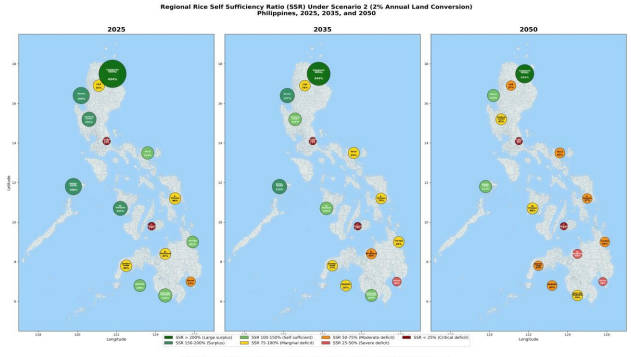

Figure 3. Regional rice self-sufficiency ratio (SSR) under Scenario 2 (2% annual land conversion), Philippines, 2025, 2035, and 2050. Circle size and color represent SSR: larger circles indicate higher self-sufficiency. SSR = milled production/demand x 100. Source: Authors' projections based on PSA regional data.

Table 6. Regional self-sufficiency ratio (SSR, %) under Scenario 2 (2% annual land conversion), 2025, 2035, and 2050.

Region	SSR 2025	SSR 2035	SSR 2050	Status 2050	Classification
Cagayan Valley	434%	344%	242%	Surplus	*Food basket*
Ilocos	199%	157%	110%	Surplus	*Food basket*
MIMAROPA	198%	159%	113%	Surplus	*Food basket*
Central Luzon	155%	122%	85%	Marginal deficit	*Transition region*
Western Visayas	151%	122%	88%	Marginal deficit	*Transition region*
SOCCSKSARGEN	136%	109%	78%	Marginal deficit	*Transition region*
BARMM	108%	87%	63%	Moderate deficit	*Deficit region*

Bicol	114%	91%	65%	Moderate deficit	*Deficit region*
Caraga	103%	83%	60%	Moderate deficit	*Deficit region*
Eastern Visayas	98%	79%	57%	Moderate deficit	*Deficit region*
CAR	97%	79%	57%	Moderate deficit	*Deficit region*
Zamboanga	96%	77%	54%	Moderate deficit	*Deficit region*
Northern Mindanao	87%	69%	48%	Severe deficit	*Deficit region*
Davao	51%	40%	28%	Severe deficit	*Deficit region*
Central Visayas	19%	16%	11%	Critical deficit	*Permanent deficit*
CALABARZON	14%	11%	8%	Critical deficit	*Permanent deficit*

Note: *SSR = (Regional milled rice production / Regional demand) x 100. Demand = regional population x 119 kg/yr per capita consumption. Production projected using Holt's yield forecast with 2% annual area reduction. Status classification: Surplus (SSR > 100%), Marginal deficit (75-100%), Moderate deficit (50-75%), Severe deficit (25-50%), Critical deficit (< 25%). Regions ranked by 2050 SSR descending. NCR excluded.*

Discussion

A Closing Window: Why Yield Gains Cannot Outrun the Problem

The central finding of this study is that Philippine rice production is caught between two structural forces that incremental yield gains cannot overcome. On the demand side, population continues to grow at 0.8% annually, adding roughly 900,000 rice consumers each year. On the supply side, the productive land base has ceased expanding and, under documented historical conversion rates (Taer, 2025), is contracting. The Holt smoothing forecasts show that yield is the only variable still moving in a favorable direction, but at 0.024 MT/ha/year, it is advancing too slowly to compensate. At this rate, closing the yield gap to the 6 to 8 MT/ha achievable potential (Bordey et al., 2020) would take 75 to 160 years. The Philippines does not have that kind of time. By 2035, even the baseline scenario (no land loss) projects a sufficiency gap of 1.56 million MT, and the historical rate scenario projects 3.96 million MT.

This finding extends and sharpens the conclusions of Bartelet et al. (2025), who documented the 9% production growth from 2013 to 2023 but did not project forward. What the forecasts reveal is that the growth Bartelet et al. documented was a product of yield improvement on a stable area base, and that both components are approaching their limits. The area plateau observed from 2013 to 2025 represents the best case, one that requires active land protection to maintain.

The Collapse of the Food Basket System

National aggregate statistics mask a spatial story that is, in many ways, more alarming than the national projections themselves. The Philippine rice food system has long operated on a model of interregional transfers: a small number of surplus regions (the food baskets) produce more than they consume and supply the deficit regions. The regional SSR analysis (Section 3.7, Figure 3) shows that this system is structurally weakening.

In 2025, five regions function as food baskets, led by Cagayan Valley (SSR 434%), Ilocos (199%), MIMAROPA (198%), Central Luzon (155%), and Western Visayas (151%). Together, these five generate the transferable surplus that feeds Manila, CALABARZON (SSR 14%), Central Visayas (19%), Davao (51%), and the other deficit regions. By 2050 under the historical conversion rate, this system narrows to three surplus regions, with Central Luzon and Western Visayas shifting to deficit. The country's internal food supply becomes dependent on Cagayan Valley, which, while still producing a large surplus (SSR 242%), is geographically isolated from the major consumption centers by the Sierra Madre mountain range and is connected by limited road and rail infrastructure (Briones, 2017).

The policy implication is geographic targeting. Investment in rice production yields the highest return in the regions that can still achieve and sustain surplus status: Cagayan Valley's irrigated lowlands, Ilocos's established farming systems, and MIMAROPA's expanding rice areas (Inocencio & Inocencio, 2020). Regions where urbanization has irreversibly consumed rice lands, particularly CALABARZON and Central Visayas, should be managed as permanent deficit regions with dedicated supply chain infrastructure connecting them to surplus sources. The proposed National Land Use Act (NaLUA), pending in Congress for over two decades, is most urgently needed in the transition regions (Central Luzon, Western Visayas, Northern Mindanao) where land conversion has not yet reached irreversible levels but is accelerating (Araza et al., 2026).

Deepening Import Dependency and Systemic Vulnerability

The import trajectory documented in this study (from 0.89 million MT in 2017 to 4.68 million MT in 2024) represents the fastest growth in import dependency in Philippine history (CPBRD, 2026). The RTL and EO 62 policy sequence has, intentionally or not, restructured the Philippine rice supply to rely on imported grain for more than one quarter of

consumption. The scenario projections show this is not a temporary condition. Even under the most optimistic baseline (no land loss), the IDR reaches 14% by 2050. Under the historical conversion rate, it reaches 48%, a level at which nearly half of every kilogram of rice consumed by Filipinos would come from abroad.

Dawe (2010) documented the catastrophic consequences of such dependency during the 2007 to 2008 rice crisis, when India and Vietnam imposed export bans that tripled international rice prices within months. At the projected Scenario 2 import volumes of nearly 8 million MT by 2050, the Philippines would be importing more rice than any nation currently does. The concentration of imports from a single primary supplier (Vietnam) amplifies the vulnerability. Building resilience at these levels of dependency requires diversifying import sources across Vietnam, Thailand, Myanmar, and India; maintaining strategic reserves of at least 30 to 50 days of supply; and strengthening regional distribution systems that can redirect domestic surplus to deficit areas during import disruptions.

Comparison with Published Evidence

Table 8 maps the relationship between this study's findings and the published literature across eight thematic domains.

Table 8. Literature mapping: Comparison of current findings with published evidence.

Source	Key Finding from Literature	How Current Study Extends or Challenges	Domain
Bartelet et al. (2025), PLOS ONE	PSA data 2013-2023; documented 9% national production increase and regional stagnation	Current study confirms the 9% growth finding and extends the series to 2025. Adds forecasting (Holt smoothing) and land conversion scenario analysis does not present in Bartelet et al.	Production trends
Taer (2025), Food Security	Traced decline of Philippine rice lands; reported 97,593 ha/yr conversion rate (1988-2016)	This conversion rate is adopted as Scenario 2 baseline (2%/yr). The current PSA area harvested series (1987-2025) shows area expansion, but this metric includes double cropped land counted twice, while Taer measures physical land area. Both findings may be simultaneously correct: physical rice land declined while cropping intensity increased through expanded irrigation and double cropping.	Land conversion
Bordey et al. (2020), PhilRice	ASEAN competitiveness assessment; yield gap of 6-8 MT/ha potential	Current study uses the 6-8 MT/ha benchmark to calculate a 44% yield gap. The scenario analysis shows that closing this gap is the only pathway to reduced import dependency, requiring 75-160 years at current improvement rates.	Yield gap
Cororaton (2020), PIDS; Clarete et al. (2021)	RTL impact: 10-15% farmgate price decline; import surge post-2019	Current study extends the import analysis to 2024, documenting the further surge to 4.68 M MT under EO 62 and the IDR reaching 28%, the highest since 1988. The farmgate price recovery to PHP 23.48/kg in 2024 was not captured in earlier analyses.	Trade policy
Dawe (2010), FAO/Earthscan	2007-2008 rice crisis: export bans tripled prices; import dependency risks	The scenario projections (IDR reaching 33-69% by 2050) demonstrate that the vulnerability Dawe warned about is structurally deepening. At Scenario 2 levels (IDR 48%), a crisis similar to 2007-2008 would be catastrophic.	Import vulnerability
Carating et al. (2014); Araza et al. (2026)	Central Luzon conversion 3-5%/yr; r=0.89 cropland-urban correlation nationally	Adopted as Scenario 3 (4%/yr). The Araza et al. (2026) finding that 31% of conversions occur within protected zones underscores the enforcement failure driving continued land loss.	Land use policy
Scott (1976); Borras (2006)	Structural extraction in SE Asian rice farming; post-reform agrarian inequity	The persistence of tenancy and sharecropping arrangements documented by Scott and Borras provides the theoretical	Agrarian structure

		context for understanding why national production gains may not translate to food security at the household level, a dimension that warrants future research integrating macro and micro level data.	
Peng et al. (2004); Stuecker et al. (2018)	10% yield decline per 1C; ENSO accounts for 10% production variability	The current model does not incorporate climate scenarios, representing a conservative (optimistic) assumption. If climate impacts are layered onto the land conversion scenarios, sufficiency gaps would widen beyond the projections presented.	Climate risk

Note: Sources were identified through targeted searches in Scopus, Google Scholar, PSA publications, and PhilRice databases. Only sources directly cited in the analysis and discussion are included.

The most significant contribution of this study to the existing literature is the integration of production forecasting, land-conversion scenarios, and regional self-sufficiency analysis into a unified framework. Previous studies addressed these dimensions separately. Bartelet et al. (2025) analyzed trends without forecasting. Taer (2025) documented land conversion without connecting it to sufficiency projections. No prior study has mapped the spatial distribution of rice sufficiency across Philippine regions under future land conversion scenarios. The regional SSR analysis reveals that the sufficiency challenge is not simply a question of national production versus national demand, but a question of which regions will feed which other regions, and what happens when that system breaks down.

Limitations and Future Research

Several limitations warrant acknowledgment. The PSA data covers 2013 to 2025, missing the 1980 to 2012 period of major rice land conversion. Holt's method extrapolates recent trends and cannot capture structural breaks from future policy changes, technological breakthroughs, or nonlinear climate impacts. The model does not incorporate climate change scenarios (Peng et al., 2004; Stuecker et al., 2018), which may significantly alter yield trajectories; if climate impacts are layered onto the land conversion scenarios, sufficiency gaps would widen beyond the projections presented. Population projections assume a constant 0.8% growth rate, which may overestimate demand if the demographic transition accelerates. Per capita consumption is held constant at 119 kg/year, although the long term trend is declining. The regional SSR projections assume uniform land conversion rates across all regions, whereas conversion varies substantially depending on urbanization pressure and enforcement of land use regulations. Future research should develop region-specific conversion rates, incorporate climate scenarios, and integrate household-level data on harvest distribution to assess whether regional surpluses translate to farmer food security.

CONCLUSION

This study examined the future landscape of Philippine rice production, sufficiency, and resilience through the convergence of regional trend analysis, exponential smoothing forecasting, import dependency documentation, land conversion scenario modeling, and regional self sufficiency projections. The findings present a sobering but evidence-based assessment.

The Philippines produced a record 20.06 million MT of palay in 2023, yet national production grew by less than 1% annually over the 2013 to 2023 decade. Area harvested has stabilized at approximately 4.7 million hectares, with production gains driven solely by modest yield improvements that average well below half the achievable potential. Rice imports have surged from 0.89 million MT in 2017 to 4.68 million MT in 2024, the highest in nearly four decades, elevating the import dependency ratio to 28%.

Exponential smoothing projects this trajectory to continue: by 2050, production may reach 22.5 million MT through yield gains, but projected milled rice supply of 14.2 million MT will fall short of projected demand of 16.5 million MT by approximately 2.4 million MT under the baseline (no land loss) scenario, and by up to 8.0 million MT under the historical conversion rate scenario (Taer, 2025). This gap implies sustained import dependency of 14 to 48% of national rice requirements, creating structural

vulnerability to global supply disruptions and price volatility.

At the regional level, the self-sufficiency analysis reveals a stark spatial concentration of supply vulnerability. By 2050, only three of sixteen regions (Cagayan Valley, Ilocos, MIMAROPA) retain SSR values above 100%, while Central Luzon, the country's traditional rice granary, drops to 85%. The convergence of stagnating production, deepening import reliance, and shrinking number of surplus regions points to a food system that is neither self-sufficient nor resilient, and that cannot become so through production enhancement alone.

Transforming this trajectory requires simultaneous action across three fronts: accelerating yield improvement toward the achievable potential (particularly through irrigation expansion and extension modernization), protecting agricultural lands in the transition regions (Central Luzon, Western Visayas, Northern Mindanao) where conversion has not yet reached irreversible levels, and managing import dependency through supplier diversification and strategic reserves. Without this convergent transformation, the future landscape of Philippine rice will be one of continued import dependency, extreme geographic concentration of supply in two to three food basket regions, and diminished capacity to withstand the supply shocks that global climate change and geopolitical instability will increasingly produce.

The question posed in the title of this study, whether the Philippines can still feed itself, does not admit a simple answer, but the evidence assembled here points toward a conditional one. Under current trends, and absent decisive policy intervention, the answer is no. The country is producing more rice than ever before in absolute terms yet falling further behind its own consumption needs with each passing year, importing at record volumes, losing agricultural land faster than yields can compensate, and concentrating its domestic supply into an ever-narrowing set of regions. What this study makes clear, however, is that the outcome is not yet fixed. The transition regions have not yet crossed the threshold of irreversible land loss. The yield gap remains wide enough that closing it would materially alter the sufficiency trajectory. The food basket regions still produce surpluses large enough to anchor a functional inter-regional supply system. The window for transformative action remains open — but the projections presented here are unambiguous that it is closing, and that the cost of inaction compounds with every year that the necessary reforms are deferred.

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