JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

FLOOD VULNERABILITY ASSESSMENT AND SUSTAINABLE DRAINAGE MANAGEMENT PLANNING FOR RESILIENCE-BUILDING IN FLOOD-PRONE BARANGAYS OF PALO, LEYTE

Edmund M. Regato
Assistant to the Dean - FREM
Saint Paul School of Professional Studies
Palo, Leyte, Philippines
Email: edmund.regato@spsps.edu.ph

ABSTRACT

Flooding remains one of the most prevalent and destructive environmental hazards in the Philippines, causing significant social, economic, and environmental impacts on vulnerable communities. The Municipality of Palo, Leyte, is frequently affected by recurrent flooding arising from the combination of climatic, hydrological, topographical, and anthropogenic factors. This study assessed the level of flood vulnerability and the condition of existing drainage systems in selected flood-prone barangays of Palo, Leyte, identified the perceived causes of flooding, explored the perspectives of key local officials, and developed a Sustainable Drainage Management Plan to enhance community resilience. A convergent parallel mixed-methods design was employed. Quantitative data were gathered from 259 household respondents, selected through proportionate allocation and simple random sampling from 735 households, using a validated researcher-made questionnaire. Qualitative data were collected through semi-structured interviews with eight purposively selected key informants from the Municipal Disaster Risk Reduction and Management Office (MDRRMO), Municipal Engineering Office (MEO), Solid Waste Management Office (SWMO), and five barangays. Quantitative data were analyzed using frequency counts, percentages, weighted means, and rankings; qualitative data were analyzed through reflexive thematic analysis, and both strands were integrated at the interpretation stage. Respondents reported high flood exposure (M = 3.74) and sensitivity (M = 3.88), indicating significant vulnerability to flooding events. Adaptive capacity was moderate (M = 3.28), reflecting limitations in preparedness, response mechanisms, and institutional support. The drainage system was rated moderately effective (M = 3.13), with maintenance receiving the lowest ratings and concerns centering on inadequate infrastructure, clogged canals, and poor solid waste management. Heavy rainfall and typhoons (M = 4.20), clogged drainage canals due to garbage (M = 4.09), poor solid waste management (M = 4.07), and inadequate drainage infrastructure (M = 4.04) were the leading perceived causes of flooding. Five themes emerged from the interviews: inadequate drainage infrastructure, solid waste management challenges, vulnerability of low-lying communities, moderate disaster preparedness, and the need for integrated flood management; these corroborated the survey results. Flood vulnerability in Palo, Leyte, is shaped by the interaction of environmental, infrastructural, and socio-institutional factors and cannot be addressed by engineering measures alone. A Sustainable Drainage Management Plan and Resilience-Building Framework anchored on Integrated Flood Management (IFM), climate change adaptation, ecosystem-based approaches, and community participation are proposed to strengthen resilience and reduce future flood risks.

Keywords: *flood vulnerability; drainage management; climate resilience; urban flooding; integrated flood management; Palo, Leyte*

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

INTRODUCTION

Background of the Study

Flooding is one of the most frequent and destructive natural hazards affecting communities worldwide. It poses significant threats to human life, property, livelihoods, infrastructure, and environmental sustainability. In recent decades, the occurrence and intensity of flooding have increased because of climate change, rapid urbanization, land-use change, environmental degradation, and inadequate drainage infrastructure. The Intergovernmental Panel on Climate Change (IPCC, 2023) reports that extreme weather events, particularly heavy rainfall and tropical cyclones, have become more frequent and intense, increasing flood risk in many regions of the world.

In developing countries such as the Philippines, flooding remains a major environmental and developmental challenge. The country's location within the western Pacific typhoon belt and its exposure to monsoon systems make it highly vulnerable to hydrometeorological hazards. The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA, 2024) reports that the country experiences an average of about twenty tropical cyclones annually, many of which cause extensive flooding, displacement of populations, destruction of infrastructure, and economic losses. Climate change has further intensified rainfall variability, heightening the vulnerability of communities in low-lying, coastal, and riverine areas.

Flooding is no longer viewed solely as a natural phenomenon but as the product of complex interactions between environmental conditions and human activities (Wisner et al., 2004). In many urban and peri-urban communities, flood risks are aggravated by inadequate drainage systems, improper solid waste disposal, encroachment into waterways, deforestation, and uncontrolled land development. These factors reduce the capacity of natural and engineered drainage systems to manage stormwater runoff, leading to recurrent flooding even during moderate rainfall events (Jha et al., 2012).

The Municipality of Palo, Leyte, is among the local government units in Eastern Visayas that regularly experience flooding. Situated along the eastern coast of Leyte and characterized by low-lying terrain, river systems, and coastal influences, several of its barangays are highly susceptible to flood hazards. The municipality's exposure was demonstrated dramatically in 2013, when Typhoon Haiyan (Yolanda) generated destructive storm surges along the Leyte Gulf coast, including Palo (Lagmay et al., 2015). Beyond such extreme events, heavy rainfall associated with tropical cyclones and monsoons frequently causes waterways to overflow and floodwater to accumulate in residential areas. Increasing urbanization, population growth, and changing land-use patterns have placed additional pressure on existing drainage infrastructure.

Recurring flooding in Palo has disrupted economic activities, educational services, transportation, public health, and overall community welfare. Residents of flood-prone barangays often experience damage to homes and personal property, temporary displacement, loss of income, and exposure to waterborne diseases. These impacts underscore the need for a comprehensive flood vulnerability assessment and for sustainable drainage management interventions.

Flood vulnerability assessment provides a systematic approach to understanding the degree to which communities are susceptible to flood-related hazards. Vulnerability encompasses three major dimensions: exposure, sensitivity, and adaptive capacity (Adger, 2006; IPCC, 2023). Exposure refers to the extent to which individuals and communities are subjected to flood hazards; sensitivity pertains to the degree to which people and systems are affected by flooding; and adaptive capacity reflects the ability of communities to prepare for, respond to, and recover from flood events. Understanding these dimensions is essential for identifying areas requiring intervention and for strengthening resilience.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Equally important is the evaluation of drainage systems, which serve as critical infrastructure for stormwater management and flood mitigation. Effective drainage systems convey runoff rapidly, reduce water accumulation, and minimize flood risk; however, poor maintenance, inadequate capacity, clogged waterways, and aging infrastructure often compromise their performance (Butler et al., 2018). Assessing drainage functionality, maintenance conditions, and design adequacy is therefore necessary for developing sustainable flood management strategies.

Sustainable drainage management has gained increasing recognition as an approach that addresses flood risk while promoting environmental sustainability. Sustainable drainage systems manage stormwater through integrated structural and non-structural measures that mimic natural hydrological processes, including drainage rehabilitation, green infrastructure, ecosystem-based adaptation, community participation, and integrated flood management practices (Fletcher et al., 2015). By enhancing drainage performance and reducing vulnerability, sustainable drainage management contributes significantly to resilience-building.

Given the recurring flood problems in Palo, Leyte, there is a need to examine existing conditions of flood vulnerability and drainage management in its flood-prone barangays. This study provides empirical evidence to support local government planning, infrastructure improvement, disaster risk reduction initiatives, and climate adaptation strategies, and it develops a Sustainable Drainage Management Plan intended to strengthen community resilience and contribute to sustainable development in flood-prone areas.

Theoretical Framework

This study is anchored on the Integrated Flood Management (IFM) concept of the World Meteorological Organization (WMO, 2009), supported by the IPCC Vulnerability Framework, the Pressure-State-Response Model, and the Sendai Framework for Disaster Risk Reduction 2015–2030.

Integrated Flood Management

IFM serves as the primary theoretical foundation of the study. It promotes a holistic approach to flood management that integrates land and water resources development within river basins, with the aim of maximizing the net benefits from floodplains while minimizing loss of life and damage caused by floods (WMO, 2009). Rather than relying solely on structural measures such as dikes and drainage canals, IFM advocates a combination of structural and non-structural interventions, stakeholder participation, environmental sustainability, and risk-based planning. The approach emphasizes that effective flood management requires balancing flood protection with sustainable development objectives. In the context of Palo, Leyte, IFM provides a framework for assessing flood vulnerability and for developing drainage management strategies that address both the physical and socio-economic dimensions of flood risk.

IPCC Vulnerability Framework

The IPCC conceptualizes vulnerability as a function of exposure, sensitivity, and adaptive capacity (IPCC, 2023; see also Adger, 2006). Exposure refers to the degree to which a community experiences flood hazards; sensitivity pertains to the extent of adverse impacts resulting from flood events; and adaptive capacity refers to the ability of individuals, institutions, and communities to anticipate, prepare for, cope with, and recover from flood-related impacts. This framework is the basis for assessing the level of flood vulnerability among residents of the selected flood-prone barangays.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Pressure-State-Response Model

The Pressure-State-Response (PSR) Model of the Organisation for Economic Co-operation and Development (OECD, 1993) explains the relationship between human activities and environmental conditions. Anthropogenic pressures, such as improper waste disposal, urban expansion, and inadequate infrastructure, alter the state of environmental systems, which in turn require responses from governments and communities. The model supports the assessment of drainage conditions and the identification of appropriate interventions to improve flood management practices.

Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction 2015–2030 sets four priorities for action: understanding disaster risk, strengthening disaster risk governance, investing in disaster risk reduction for resilience, and enhancing disaster preparedness for effective response and recovery (United Nations Office for Disaster Risk Reduction [UNDRR], 2015). It recognizes that disaster resilience requires collaboration among government agencies, communities, and other stakeholders. Its principles guide the resilience-building component of this study and the formulation of sustainable drainage management strategies.

Review of Related Literature

This section reviews literature on flood vulnerability, climate change and flood risk, integrated flood management, sustainable drainage systems, drainage infrastructure, solid waste management, and community resilience, drawing on international, national, and local perspectives.

Flood Vulnerability Assessment

Flood vulnerability assessment is a systematic process of evaluating the susceptibility of individuals, communities, infrastructure, and environmental systems to the adverse impacts of flooding. It provides a framework for understanding how physical, social, economic, and institutional factors influence the ability of communities to cope with flood hazards. The IPCC (2023) defines vulnerability as the propensity or predisposition of a system to be adversely affected by climate-related hazards, commonly viewed as a function of three interrelated dimensions: exposure, sensitivity, and adaptive capacity.

Exposure refers to the presence of people, infrastructure, housing, and economic assets in locations susceptible to flooding. Communities near rivers, coastlines, floodplains, and low-lying areas generally experience higher exposure, which determines the likelihood that individuals and properties will encounter flood hazards. *Sensitivity* refers to the extent to which people and systems are affected by flooding; housing conditions, livelihood dependence, health status, and socio-economic characteristics influence sensitivity, so that communities with fragile housing, limited resources, and climate-sensitive livelihoods are generally more vulnerable. *Adaptive capacity* pertains to the ability of communities to anticipate, prepare for, respond to, and recover from flooding, and includes access to information, early warning systems, preparedness measures, institutional support, financial resources, and community networks.

Vulnerability assessment is widely regarded as an essential component of disaster risk reduction and climate adaptation planning. Cutter et al. (2010) argued that measuring baseline vulnerability and resilience helps policymakers identify at-risk populations and prioritize interventions, while Birkmann (2013) emphasized that vulnerability assessments provide the information needed to develop evidence-based adaptation strategies and reduce future disaster losses. In the Philippine context, such assessments have become increasingly important because of the country's high exposure to hydrometeorological hazards, and research across regions highlights the need for localized assessments that consider both the physical and socio-economic dimensions of flood risk.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Climate Change and Flood Risks

Climate change has emerged as one of the most significant drivers of increased flood risk worldwide. Rising global temperatures have altered precipitation patterns, increased atmospheric moisture content, intensified extreme rainfall events, and contributed to sea-level rise. The IPCC Sixth Assessment Report (IPCC, 2023) concludes that the frequency and intensity of heavy precipitation events have increased in many regions, contributing to more frequent and severe flooding, particularly in coastal areas, river basins, and urban environments. Coastal cities face especially steep increases in projected flood losses as sea levels rise and urban populations grow (Hallegatte et al., 2013).

The Philippines is recognized as one of the most climate-vulnerable countries globally. Its location in the western Pacific exposes it to frequent tropical cyclones, monsoon rains, storm surges, and flooding, and PAGASA (2024) reports that climate variability and changing rainfall patterns have significantly influenced flood occurrence in many parts of the country. Climate change affects flooding through several mechanisms: increased rainfall intensity generates runoff volumes that exceed the capacity of natural and engineered drainage systems; rising sea levels increase the risk of coastal flooding and impede the discharge of stormwater into receiving water bodies; and stronger tropical cyclones produce more intense rainfall and prolonged flooding.

The Asian Development Bank (ADB, 2023) found that urban areas in Southeast Asia face increasing flood risk from the combined effects of climate change, population growth, and inadequate infrastructure, and emphasized integrating climate adaptation measures into urban planning and drainage management. For municipalities such as Palo, Leyte, whose coastal location exposes them to typhoon-related rainfall and storm surge, local governments must develop adaptive strategies that address both current and future flood risks.

Integrated Flood Management

IFM is a comprehensive approach that seeks to maximize the benefits of floodplains while minimizing flood-related losses, integrating water resources management, land-use planning, environmental conservation, and disaster risk reduction (WMO, 2009). Traditional approaches often focus on structural interventions such as levees, floodwalls, and drainage canals; while these can reduce flood risk, they may not address the underlying causes of vulnerability. IFM recognizes flooding as a natural process that must be managed through a combination of structural and non-structural measures. Its key principles are:

1. managing the water cycle as a whole;
2. integrating land and water management;
3. adopting a risk-based approach;
4. promoting stakeholder participation;
5. enhancing institutional coordination; and
6. supporting sustainable development.

WMO (2009) emphasized that successful flood management requires collaboration among government agencies, communities, private organizations, and civil society so that interventions are socially acceptable, economically viable, and environmentally sustainable. In Palo, Leyte, IFM provides an appropriate framework for addressing recurrent flooding through infrastructure improvement, community participation, environmental management, and disaster preparedness.

Sustainable Urban Drainage Systems

Sustainable Urban Drainage Systems (SuDS) are drainage approaches designed to mimic natural hydrological processes while reducing flood risk and improving environmental quality. Unlike conventional systems that focus

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

solely on the rapid conveyance of stormwater, SuDS manage runoff at its source and promote infiltration, storage, and treatment (Fletcher et al., 2015). They provide multiple benefits, including flood reduction, water-quality improvement, groundwater recharge, biodiversity enhancement, and climate resilience (ADB, 2023). Common SuDS components include retention ponds, detention basins, constructed wetlands, bioswales, permeable pavements, rain gardens, green roofs, and infiltration trenches.

Fletcher et al. (2015) traced the evolution of SuDS and related approaches (low-impact development, best management practices, and water-sensitive urban design) and showed how they have broadened stormwater management from flood conveyance to the restoration of natural flow regimes, water-quality protection, and support for ecosystem services and urban sustainability. In developing countries, sustainable drainage is increasingly recognized as a cost-effective and environmentally responsible complement to conventional drainage infrastructure, particularly in flood-prone municipalities whose drainage networks cannot accommodate growing runoff volumes.

Drainage Infrastructure and Flood Management

Drainage systems reduce flood risk by moving stormwater away from populated areas, preventing water accumulation, minimizing property damage, and protecting public health. They consist of interconnected networks of canals, culverts, pipes, channels, and outlets designed to collect and transport stormwater, and their performance depends on design capacity, maintenance practices, hydraulic efficiency, and environmental conditions (Butler et al., 2018).

Poor drainage conditions are among the most common causes of urban flooding. Inadequate capacity, sediment accumulation, structural deterioration, and blockage by solid waste often reduce system effectiveness, making regular maintenance and infrastructure upgrading essential (Tingsanchali, 2012). Studies in flood-prone urban areas consistently identify drainage deficiencies as major contributors to recurrent flooding; evaluating drainage functionality, maintenance, and capacity is therefore essential in developing effective mitigation strategies.

Solid Waste Management and Flooding

Improper solid waste management is widely recognized as a significant contributor to urban flooding. Waste disposed of in drainage canals, waterways, and rivers obstructs flow and reduces hydraulic capacity, often causing water stagnation, overflow, and localized flooding during rainfall (Lamond et al., 2012; United Nations Human Settlements Programme [UN-Habitat], 2021). In the Philippines, improper waste disposal remains a persistent problem despite the enactment of Republic Act No. 9003, the Ecological Solid Waste Management Act of 2000. Inadequate segregation, limited collection services, and low public awareness contribute to drainage blockage and environmental degradation. Effective solid waste management—community participation, waste segregation, regular collection, and strict enforcement of environmental regulations—is therefore an essential component of flood risk reduction.

Community Resilience and Disaster Risk Reduction

Community resilience refers to the ability of individuals, households, and communities to anticipate, withstand, adapt to, and recover from disasters, and has become central to disaster risk reduction and climate adaptation planning. The Sendai Framework (UNDRR, 2015) emphasizes resilience-building through risk understanding, governance strengthening, investment in risk reduction, and enhanced preparedness. In the Philippines, Republic Act No. 10121, the Philippine Disaster Risk Reduction and Management Act of 2010, institutionalizes this proactive orientation through local DRRM offices and plans.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Norris et al. (2008) characterized community resilience as a set of networked adaptive capacities—economic development, social capital, information and communication, and community competence—that enable communities to respond effectively to disasters and recover more rapidly. Local knowledge, volunteerism, preparedness activities, and stakeholder collaboration contribute significantly to effective flood management, and resilient communities are more likely to support sustainable environmental practices and participate in risk reduction. For the flood-prone barangays of Palo, Leyte, strengthening resilience requires investment in preparedness programs, early warning systems, infrastructure improvement, and participatory governance.

Related Studies

Several studies have examined flood vulnerability, drainage management, and disaster resilience in different contexts. Abon et al. (2011) reconstructed the 2009 Tropical Storm Ketsana (Ondoy) flood in the Marikina River basin, Metro Manila, combining field-based flood-height information with hydrological analysis, and showed how extreme rainfall over an urbanized catchment produced catastrophic flooding—underscoring the need for integrated flood planning in Philippine urban areas.

Santos and Cruz (2021) assessed drainage system performance in coastal municipalities of Eastern Visayas and found that aging infrastructure, insufficient maintenance, and increasing rainfall intensity contributed to frequent flooding, emphasizing infrastructure upgrading and preventive maintenance. Garcia and Santos (2022) examined community resilience in flood-prone barangays in Central Luzon and found that adaptive capacity was strongly influenced by access to information, social networks, and local government support, with better-prepared communities experiencing lower disaster impacts. Internationally, ADB (2023) highlighted the importance of integrating climate adaptation measures into urban drainage systems and recommended sustainable drainage, ecosystem-based adaptation, and stakeholder participation to improve flood resilience. Together, these studies demonstrate the multidimensional nature of flood vulnerability and the importance of integrating physical infrastructure improvements with social and institutional interventions.

Synthesis of the Reviewed Literature

The reviewed literature establishes that flooding is a complex environmental and socio-economic issue shaped by climatic, hydrological, infrastructural, and human factors, and that climate change has intensified rainfall patterns and flood risks, particularly in developing countries such as the Philippines. Flood vulnerability is commonly assessed through exposure, sensitivity, and adaptive capacity; communities with high exposure and sensitivity and low adaptive capacity are most susceptible to adverse impacts. Drainage infrastructure is pivotal: well-designed and properly maintained systems facilitate efficient stormwater management, whereas inadequate infrastructure, poor maintenance, and waste-induced blockage contribute to recurrent flooding. IFM and SuDS provide theoretical and practical approaches that emphasize stakeholder participation, environmental sustainability, infrastructure development, and risk-informed planning, while preparedness, institutional support, social capital, and adaptive capacity determine a community's ability to cope with flood hazards.

Research Gap

Although numerous studies have investigated flood hazards, climate change impacts, drainage systems, and disaster resilience, relatively few have examined flood vulnerability, drainage system performance, perceived causes of flooding, and resilience-building together within a localized municipal setting. Research specifically focused on the flood-prone barangays of Palo, Leyte, is limited, despite the municipality's recurring flood experience and increasing climate-related risks. Moreover, existing studies often emphasize hazard mapping or engineering solutions without adequately integrating community perceptions, institutional perspectives, and resilience-building strategies. This study addresses these gaps by combining quantitative and qualitative approaches to assess flood vulnerability, evaluate drainage conditions, identify perceived causes of flooding, and

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

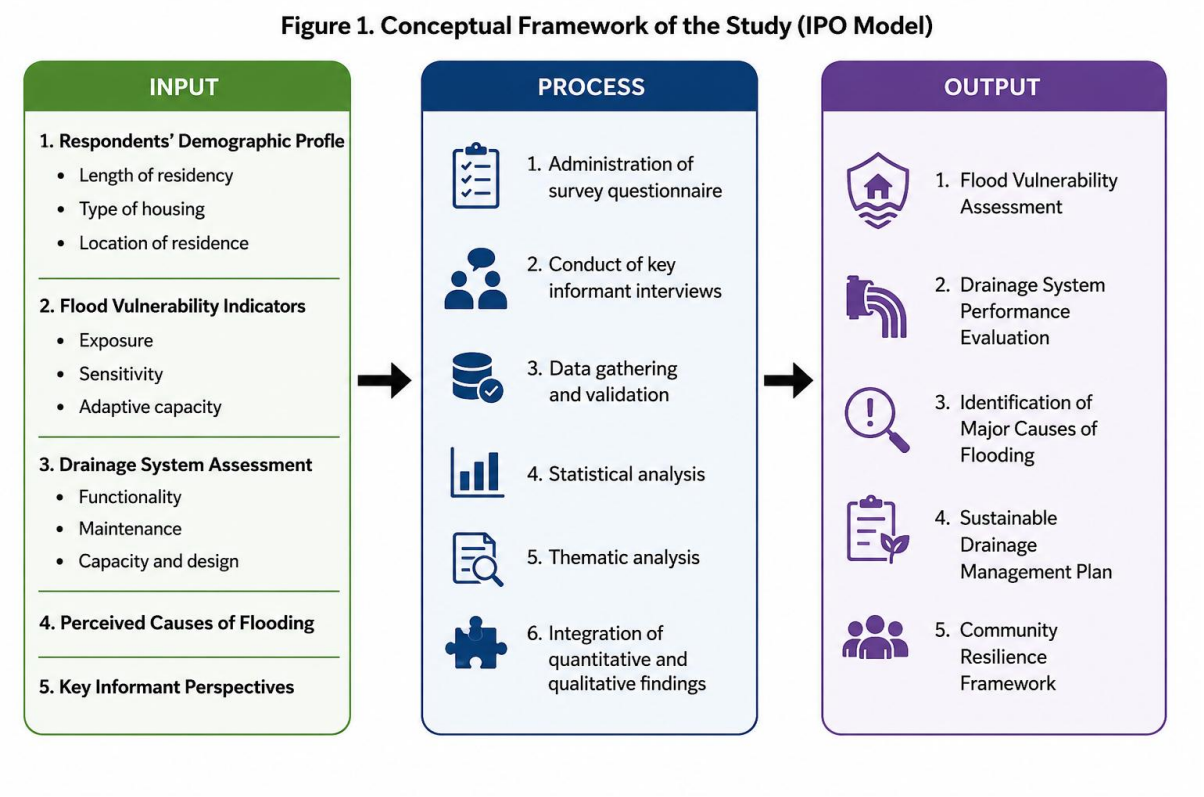
develop a Sustainable Drainage Management Plan tailored to the needs and conditions of flood-prone barangays in Palo, Leyte.

Research Paradigm and Conceptual Framework

The study adopted the Input–Process–Output (IPO) paradigm to illustrate the logical flow of the investigation (Figure 1). The *input* consists of the respondents' profile; the dimensions of flood vulnerability (exposure, sensitivity, and adaptive capacity); the condition of the drainage system (functionality, maintenance, and capacity and design); the perceived causes of flooding; and the perspectives of key informants from the Municipal Engineering Office, the MDRRMO, the Municipal Solid Waste Management Office, and the barangay captains.

The *process* comprises the administration of the researcher-made questionnaire, the conduct of semi-structured interviews, data gathering and validation, statistical analysis using frequency, percentage, and weighted mean, thematic analysis, and the integration and interpretation of quantitative and qualitative findings. The *output* comprises the flood vulnerability assessment, the drainage system performance evaluation, the identification of the major causes of flooding, and a Sustainable Drainage Management Plan with an accompanying community resilience framework that proposes evidence-based engineering, environmental management, disaster risk reduction, and community resilience strategies.

Figure 1. Conceptual Framework of the Study (Input–Process–Output Model)



Research Objectives

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

This study aimed to assess flood vulnerability and sustainable drainage management conditions in selected flood-prone barangays of Palo, Leyte. Specifically, it sought to answer the following research questions (RQs):

1. What is the profile of the respondents in terms of (a) length of residency in the barangay, (b) type of housing, and (c) location of residence?

2. What is the level of flood vulnerability in terms of (a) exposure, (b) sensitivity, and (c) adaptive capacity?

3. What is the condition of the drainage system in terms of (a) functionality, (b) maintenance, and (c) capacity and design?

4. What are the perceived causes of flooding in the selected barangays?

5. What themes emerge from the perspectives of key informants regarding flood vulnerability and drainage management?

6. Based on the findings, what Sustainable Drainage Management Plan may be proposed to strengthen community resilience in flood-prone barangays of Palo, Leyte?

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

METHODS

Research Design

The study used a convergent parallel mixed-methods design (Creswell & Creswell, 2023). Mixed-methods research combines quantitative and qualitative approaches to provide a more comprehensive understanding of a research problem than either approach alone; in the convergent design, both types of data are collected in the same phase, analyzed separately, and integrated during interpretation (Fetters et al., 2013). The quantitative strand assessed flood vulnerability, drainage system conditions, and perceived causes of flooding among residents. The qualitative strand explored the experiences, perceptions, and insights of key informants regarding flood management challenges, existing interventions, and resilience-building strategies. Integration of the two datasets enabled triangulation and enhanced the credibility and comprehensiveness of the findings.

Research Locale

The study was conducted in selected flood-prone barangays of the Municipality of Palo, Province of Leyte, Eastern Visayas Region, Philippines. Palo is a first-class municipality situated along the eastern coast of Leyte and is characterized by low-lying terrain, coastal zones, river systems, and urbanizing communities. Because of its geographic and topographic characteristics, several barangays regularly experience flooding caused by heavy rainfall, tropical cyclones, river overflow, storm surges, and inadequate drainage. The study barangays were identified from records of the MDRRMO, the MEO, and barangay officials on recurring flood incidents and vulnerability to flood hazards. The municipality was chosen because of its recurring flooding, increasing climate-related risks, and ongoing efforts to improve drainage infrastructure and disaster resilience.

Participants

Household Respondents

The quantitative respondents were 259 household residents of the selected flood-prone barangays. Inclusion criteria were that the respondent (a) was at least 18 years old, (b) had resided in the barangay for at least one year, (c) had experienced flooding in the community, and (d) voluntarily agreed to participate. Respondents were considered appropriate sources of information because of their direct experience with flooding and familiarity with local drainage conditions.

Key Informants

The qualitative strand involved eight key informants purposively selected for their expertise, roles, and direct involvement in flood risk reduction, drainage management, environmental management, and disaster preparedness in Palo (Table 1). Purposive sampling is a non-probability technique used to identify information-rich participants with relevant expertise and first-hand experience of the research problem (Patton, 2015). The informants' responsibilities for planning, implementing, and overseeing flood mitigation programs, drainage infrastructure, solid waste management, disaster preparedness, and community governance enabled them to provide rich, credible, and context-specific information that complemented the survey findings.

Table 1. Composition of Key Informants

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Office / Position	Number	Code
Municipal Disaster Risk Reduction and Management Officer	1	KI-1
Municipal Engineer	1	KI-2
Municipal Solid Waste Management Officer	1	KI-3
Barangay Captains of the study barangays	5	KI-4 to KI-8
Total	**8**	

Sample Size and Sampling Procedure

Barangay records indicated a total of 735 households in the selected barangays. As surveying the entire population was not feasible, the sample size was determined using Slovin's formula with a 5% margin of error:

$$n = N / (1 + N e^2) = 735 / [1 + 735(0.05)^2] = 735 / (1 + 1.8375) = 735 / 2.8375 = 259.03 \approx 259$$

where n is the sample size, N is the total number of households, and e is the margin of error (0.05).

Proportionate allocation was used so that the number of respondents from each barangay corresponded to its share of the total household population; barangays with larger household populations therefore contributed proportionately more respondents. Within each barangay, households were selected through simple random sampling, giving every eligible household an equal chance of selection. Combining proportionate allocation with simple random sampling minimized sampling bias and supported the representativeness of the findings for the target population.

Research Instruments

The primary instrument was a researcher-made questionnaire (Appendix E) developed from the study objectives, a review of related literature, and the theoretical foundations of IFM, the IPCC Vulnerability Framework, and the Sendai Framework. It consisted of four parts. Part I gathered the respondents' profile (length of residency, type of housing, and location of residence). Part II assessed flood vulnerability through five items each on exposure, sensitivity, and adaptive capacity. Part III evaluated the existing drainage system through twelve items, four each on functionality, maintenance, and capacity and design. Part IV measured perceptions of eight potential causes of flooding.

Parts II and III used a five-point Likert agreement scale (5 = Strongly Agree, 4 = Agree, 3 = Moderately Agree, 2 = Disagree, 1 = Strongly Disagree). Part IV used a modified five-point scale indicating the extent to which each factor contributes to flooding (5 = Very Strong Cause, 4 = Strong Cause, 3 = Moderate Cause, 2 = Weak Cause, 1 = Not a Cause), allowing respondents to evaluate the relative contribution of natural and human-induced factors. Weighted means were interpreted using the ranges in Table 2.

Table 2. Scales and Interpretation of Weighted Means

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Scale value	Mean range	Parts II–III (agreement)	Part IV (causes)
5	4.21–5.00	Strongly Agree	Very Strong Cause
4	3.41–4.20	Agree	Strong Cause
3	2.61–3.40	Moderately Agree	Moderate Cause
2	1.81–2.60	Disagree	Weak Cause
1	1.00–1.80	Strongly Disagree	Not a Cause

Note. For the vulnerability dimensions, "Agree" is read as a high level of exposure or sensitivity and "Moderately Agree" as a moderate level of adaptive capacity or drainage effectiveness.

A semi-structured interview guide (Appendix D) was developed for the qualitative strand. Its open-ended questions sought in-depth information from the key informants on the condition of drainage systems, flood management practices, institutional challenges, and recommendations for sustainable drainage management and resilience-building. Using both the questionnaire and the interview guide enabled methodological triangulation, enhancing the depth, credibility, and trustworthiness of the findings.

Validity and Reliability of the Instrument

The questionnaire underwent content validation by a panel of three experts: an environmental management specialist, a disaster risk reduction and management expert, and a research and statistics expert. The validators evaluated each item for relevance, clarity, coherence, adequacy, and appropriateness, and their suggestions were incorporated before final administration. Content validity was quantified using the Content Validity Index (CVI), with a value of 0.80 or higher considered acceptable (Polit & Beck, 2006).

To establish reliability, the questionnaire was pilot-tested among 30 household residents of a neighboring municipality with flooding characteristics comparable to those of the study area but not included in the actual data collection, which allowed the consistency and clarity of the instrument to be evaluated without contaminating the study sample. Internal consistency was determined using Cronbach's alpha (Cronbach, 1951), which estimates the extent to which items within a scale consistently measure the same construct. Coefficients were interpreted as excellent (0.90–1.00), very good (0.80–0.89), good (0.70–0.79), acceptable (0.60–0.69), or poor (below 0.60), with an overall coefficient of 0.70 or higher regarded as indicating satisfactory internal consistency (Hair et al., 2019; Sekaran & Bougie, 2020; Tavakol & Dennick, 2011). The pilot test yielded a coefficient meeting the 0.70 threshold, indicating adequate internal consistency.

Data Collection Procedure

Data collection proceeded in six phases. **Phase 1 (Preparation):** letters requesting permission to conduct the study were submitted to the Graduate School and the Local Government Unit (LGU) of Palo, and upon approval, coordination was undertaken with barangay officials and relevant municipal offices (Appendices A–C). **Phase 2 (Validation and pilot testing):** the instrument was subjected to expert validation and pilot testing, and necessary revisions were made. **Phase 3 (Quantitative data collection):** the researcher personally administered the questionnaires to qualified respondents after explaining the purpose of the study and securing informed consent; completed questionnaires were retrieved, checked, and organized for analysis. **Phase 4 (Qualitative data collection):** key informant interviews were conducted with municipal and barangay officials, audio-recorded with permission, and supplemented with field notes. **Phase 5 (Data analysis):** quantitative data were encoded and

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

statistically analyzed, and interview recordings were transcribed, coded, and thematically analyzed. **Phase 6 (Plan development):** the integrated findings served as the basis for formulating the proposed Sustainable Drainage Management Plan.

Data Analysis

Quantitative Analysis

Frequencies and percentages were used to describe the respondents' profile, where the percentage is computed as $P = (f / N) \times 100$, with f the frequency of responses and N the total number of respondents. The weighted mean, $WM = \Sigma(fx) / N$, where f is the frequency of each response, x is its assigned weight, and N is the total number of respondents, was used to determine the level of flood vulnerability, the condition of the drainage system, and the perceived causes of flooding. Dimension-level means were obtained by averaging the item means within each dimension. Ranking was used to identify the most significant perceived causes of flooding, with the highest weighted mean assigned Rank 1.

Qualitative Analysis

Interview data were analyzed using reflexive thematic analysis following Braun and Clarke (2022). The process involved (a) familiarization with the data, including verbatim transcription and repeated reading of the interview responses; (b) systematic initial coding; (c) generation of initial themes; (d) review and development of themes against the coded data and the full dataset; (e) refinement, definition, and naming of themes; and (f) interpretation and reporting. Trustworthiness was supported through methodological triangulation with the survey data and the use of audio recordings and field notes (Lincoln & Guba, 1985).

Integration

Consistent with the convergent design, the emergent themes were compared with the quantitative results at the interpretation stage to identify areas of convergence, complementarity, or divergence (Fetters et al., 2013). The integrated results are summarized in a joint display (Table 10).

Development of the Proposed Sustainable Drainage Management Plan

The proposed Sustainable Drainage Management Plan was formulated from the study findings. It incorporated (a) the flood vulnerability assessment results; (b) the drainage system assessment findings; (c) the perceived causes of flooding; (d) key informant recommendations; (e) the principles of IFM; (f) climate adaptation strategies; (g) community-based disaster risk reduction approaches; and (h) sustainable urban drainage concepts. The plan identifies strategic objectives, programs and activities, responsible offices, implementation time frames, performance indicators, and expected outcomes aimed at enhancing community resilience and reducing flood risk.

Ethical Considerations

The study adhered to established ethical standards for research involving human participants, consistent with the National Ethical Guidelines for Research Involving Human Participants (Philippine Health Research Ethics Board [PHREB], 2022). Participants were informed of the objectives, procedures, benefits, and potential risks of the study before participating (*informed consent*). Participation was entirely voluntary, and participants could withdraw at any stage without penalty (*voluntary participation*). Personal information and responses were treated with strict confidentiality, and names and identifying information were excluded from reports and publications (*confidentiality and anonymity*). The study complied with Republic Act No. 10173, the Data Privacy Act of 2012

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

(*data privacy*), and ensured that participants were not exposed to physical, psychological, or social harm (*beneficence and non-maleficence*). Interviews were recorded only with the informants' permission.

Operational Definitions

The following terms were defined operationally for this study. *Adaptive capacity* is the ability of individuals and communities to prepare for, respond to, and recover from flooding events. *Community resilience* is the capacity of a community to anticipate, withstand, adapt to, and recover from flood-related hazards. *Drainage management* is the planning, operation, maintenance, and improvement of drainage systems to control stormwater runoff and reduce flooding. *Exposure* is the degree to which individuals, households, and communities are subjected to flood hazards. *Flood vulnerability* is the susceptibility of individuals and communities to the adverse impacts of flooding based on their exposure, sensitivity, and adaptive capacity. *Resilience-building* is the process of enhancing the capacity of communities to prepare for, respond to, recover from, and adapt to flood hazards. *Sensitivity* is the extent to which people, infrastructure, and livelihoods are affected by flooding. *Sustainable drainage management* is an integrated approach to stormwater management that combines engineering, environmental, and community-based strategies to reduce flood risk while promoting environmental, social, and economic sustainability.

Scope and Delimitation

The study assessed flood vulnerability and drainage management conditions in selected flood-prone barangays of Palo, Leyte, during Academic Year 2026–2027. It examined the respondents' profile; flood vulnerability in terms of exposure, sensitivity, and adaptive capacity; drainage conditions in terms of functionality, maintenance, and capacity and design; and perceived causes of flooding, drawing on 259 household respondents and key informant interviews with municipal and barangay officials. The study did not include hydrological modeling, geographic information system (GIS)-based flood mapping, engineering design computations, or cost–benefit analysis of drainage projects; its focus was on community perceptions, vulnerability assessment, drainage system evaluation, and the development of a proposed Sustainable Drainage Management Plan.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

RESULTS

Results are presented in the order of the research questions. Quantitative data from the 259 household respondents are summarized using frequencies, percentages, weighted means, and ranks, followed by the qualitative themes, the integration of both strands, and the proposed plan.

Profile of the Respondents (RQ1)

As shown in Table 3, most respondents (171; 66.02%) had resided in their barangays for more than ten years, while only a small proportion had lived there for five years or less. Most responses therefore rest on long-term observation and actual experience of recurring flood events, and long-term residents are well placed to provide reliable assessments of historical flooding and local drainage conditions.

Table 3. Distribution of Respondents According to Length of Residency (n = 259)

Length of residency	Frequency	Percentage
More than 10 years	171	66.02
6–10 years	33	12.74
1–5 years	26	10.04
Less than 1 year	19	7.34
No response	10	3.86
Total	**259**	**100.00**

Most respondents lived in semi-concrete houses (44.02%), followed by concrete (28.96%) and light-material houses (23.17%) (Table 4). Housing type is an important indicator of flood sensitivity because structural characteristics influence vulnerability to flood damage; households in light-material dwellings generally face greater risk of structural damage than those in concrete houses.

Table 4. Distribution of Respondents According to Type of Housing (n = 259)

Type of housing	Frequency	Percentage
Semi-concrete	114	44.02
Concrete	75	28.96
Light materials	60	23.17
No response	10	3.86
Total	**259**	**100.00**

Note. Percentages may not sum to exactly 100 because of rounding.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

The largest proportion of respondents lived near roads (36.29%), followed by low-lying interior areas (26.25%) and areas near rivers or creeks (25.87%); 6.95% lived in coastal areas (Table 5). These locations are generally associated with increased flood susceptibility because of limited drainage capacity and proximity to floodwater sources, indicating that a substantial proportion of respondents live in areas naturally prone to flooding.

Table 5. Distribution of Respondents According to Location of Residence (n = 259)

Location	Frequency	Percentage
Near road	94	36.29
Low-lying interior area	68	26.25
Near river/creek	67	25.87
Coastal area	18	6.95
No response	12	4.63
Total	**259**	**100.00**

Note. Percentages may not sum to exactly 100 because of rounding.

Level of Flood Vulnerability (RQ2)

Exposure

The overall mean of 3.74 (Table 6) indicates that respondents agreed that their communities experience significant exposure to flooding. The highest-rated indicator was the occurrence of flooding during heavy rains (M = 3.98), followed by annual flooding and rapidly rising floodwaters (M = 3.76 each). Flood hazards are thus common occurrences in the selected barangays and pose substantial risks to residents and local infrastructure.

Table 6. Level of Flood Exposure (n = 259)

Indicator	Mean	Interpretation
Our barangay experiences flooding during heavy rains.	3.98	Agree
Our house is directly affected by floodwater.	3.61	Agree
Roads become impassable during floods.	3.59	Agree
Flooding occurs at least once every year.	3.76	Agree
Floodwaters rise quickly in our area.	3.76	Agree
Overall mean	**3.74**	**Agree (high exposure)**

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Sensitivity

The overall mean of 3.88 (Table 7) indicates a high degree of sensitivity to flood impacts. The highest mean was obtained for the statement that flooding affects children's schooling (M = 4.20), identifying educational disruption as one of the most significant consequences of flood events, followed by disruption of work or livelihood (M = 4.00), health-related problems (M = 3.95), and damage to household property (M = 3.66). Flood events therefore generate considerable social and economic impacts in the affected communities.

Table 7. Level of Sensitivity to Flood Impacts (n = 259)

Indicator	Mean	Interpretation
Flooding causes damage to household property.	3.66	Agree
Flooding disrupts work or livelihood activities.	4.00	Agree
Flooding affects children's schooling.	4.20	Agree
Floodwater causes health-related problems.	3.95	Agree
Recovery after flooding takes a long time.	3.60	Agree
Overall mean	**3.88**	**Agree (high sensitivity)**

Adaptive Capacity

The overall mean of 3.28 (Table 8) indicates a moderate level of adaptive capacity. Knowledge of evacuation routes obtained the highest mean (M = 3.46), suggesting that disaster awareness programs have achieved some success. However, respondents only moderately agreed that the barangay has effective disaster response measures (M = 3.13) and that the community receives government support during floods (M = 3.08), the lowest-rated indicator. Although preparedness mechanisms exist, improvements are needed to strengthen community resilience and adaptive capacity.

Table 8. Level of Adaptive Capacity (n = 259)

Indicator	Mean	Interpretation
Our household is prepared for flooding.	3.38	Moderately Agree
We receive timely flood warnings.	3.33	Moderately Agree
The barangay has effective disaster response measures.	3.13	Moderately Agree
We know evacuation routes in case of flooding.	3.46	Agree
Our community receives government support during floods.	3.08	Moderately Agree

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Overall mean	**3.28**	**Moderately Agree (moderate)**

Condition of the Drainage System (RQ3)

The overall mean of 3.13 (Table 9) indicates that respondents perceive the drainage system as only moderately effective in addressing flood risk. All twelve indicators were rated "Moderately Agree." By dimension, functionality received the highest mean (M = 3.23), followed by capacity and design (M = 3.09) and maintenance (M = 3.07). The lowest-rated indicators were regular cleaning of drainage canals (M = 2.98), the system's resistance to overflow (M = 3.01), and the immediate addressing of clogged canals (M = 3.02). These relatively low ratings for canal cleaning, maintenance responsiveness, and overflow prevention point to weaknesses in current drainage management practices and to the need for infrastructure rehabilitation, regular maintenance, and improved stormwater management.

Table 9. Assessment of Drainage System Functionality, Maintenance, and Capacity (n = 259)

Indicator	Mean	Interpretation
Functionality	**3.23**	**Moderately Agree**
Drainage canals effectively carry water away during rain.	3.29	Moderately Agree
Water drains quickly after rainfall.	3.20	Moderately Agree
Drainage systems prevent water accumulation.	3.28	Moderately Agree
Canals are properly connected and functional.	3.14	Moderately Agree
Maintenance	**3.07**	**Moderately Agree**
Drainage canals are regularly cleaned.	2.98	Moderately Agree
Proper waste management exists in drainage areas.	3.04	Moderately Agree
Clogged canals are immediately addressed.	3.02	Moderately Agree
Barangay conducts drainage maintenance activities.	3.23	Moderately Agree
Capacity and design	**3.09**	**Moderately Agree**
Drainage canals are wide enough to handle runoff.	3.06	Moderately Agree
Drainage systems are not easily overflowed.	3.01	Moderately Agree
There are enough drainage outlets.	3.06	Moderately Agree
Drainage systems are suitable for current population and land use.	3.23	Moderately Agree

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Overall mean	**3.13**	**Moderately Agree (moderately effective)**

Note. Dimension means are averages of the four item means in each dimension, computed from the item values reported in the original analysis.

Perceived Causes of Flooding (RQ4)

The overall mean of 4.00 (Table 10) indicates that respondents perceived all eight factors as strong causes of flooding. Heavy rainfall and typhoons ranked first (M = 4.20), reflecting the strong influence of climatic conditions. Clogged canals due to garbage (M = 4.09), poor solid waste management (M = 4.07), and an inadequate drainage system (M = 4.04) ranked second to fourth, followed by the low elevation of the area (M = 4.02). Lack of regular drainage maintenance (M = 3.94), overflow from rivers and creeks (M = 3.92), and rapid urbanization or building expansion (M = 3.73) received comparatively lower means but were still interpreted as strong causes. Both natural and anthropogenic factors thus contribute significantly to flooding in the study area.

Table 10. **Perceived Causes of Flooding (n = 259)**

Cause	Mean	Interpretation	Rank
Heavy rainfall and typhoons	4.20	Strong Cause	1
Clogged canals due to garbage	4.09	Strong Cause	2
Poor solid waste management	4.07	Strong Cause	3
Inadequate drainage system	4.04	Strong Cause	4
Low elevation of the area	4.02	Strong Cause	5
Lack of regular drainage maintenance	3.94	Strong Cause	6
Overflow from rivers and creeks	3.92	Strong Cause	7
Rapid urbanization/building expansion	3.73	Strong Cause	8
Overall mean	**4.00**	**Strong Cause**	

Key Informant Perspectives (RQ5)

Thematic analysis of the key informant interviews generated five major themes regarding flood vulnerability and drainage management.

Theme 1: Inadequate Drainage Infrastructure

Most key informants emphasized that existing drainage systems are insufficient to accommodate increasing runoff volumes during heavy rainfall and require rehabilitation and expansion. One municipal official stated:

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

"Many drainage canals were designed years ago and can no longer handle the volume of water generated during intense rainfall."

This theme supports the quantitative assessment of only moderate drainage performance.

Theme 2: Solid Waste Management Challenges

Key informants consistently identified improper waste disposal as a major contributor to drainage blockage and localized flooding. A barangay official explained:

"Garbage thrown into canals significantly reduces water flow and causes localized flooding."

This theme corroborates the survey finding that clogged canals and poor waste management were among the leading causes of flooding.

Theme 3: Vulnerability of Low-Lying Communities

Key informants noted that low-lying barangays experience recurring flooding because of their topography and proximity to waterways. One informant stated:

"Floodwaters accumulate quickly in low-lying areas, especially during prolonged rainfall."

This theme supports the high exposure ratings reported by residents.

Theme 4: Moderate Disaster Preparedness

Although evacuation plans and warning systems exist, several informants observed that community preparedness is uneven and that these programs require strengthening. According to one official:

"People are aware of evacuation procedures, but preparedness levels vary among households."

This observation aligns with the moderate adaptive capacity rating obtained from the survey.

Theme 5: Need for Integrated Flood Management

All key informants emphasized the need for a coordinated, multi-sectoral, and sustainable approach to flood management involving community participation. One municipal official remarked:

"Flooding cannot be solved by drainage improvements alone; it requires collaboration among government agencies and communities."

This theme highlights the relevance of IFM principles in addressing flood risk.

Integration of Quantitative and Qualitative Findings

Table 11 presents a joint display of the two strands. First, both datasets confirm that flooding is a recurring and significant problem in the selected barangays, with high exposure and sensitivity indicating substantial impacts on residents. Second, drainage systems are perceived as only moderately effective because of infrastructure limitations and maintenance deficiencies, and the interviews reinforce the need to upgrade and expand drainage facilities. Third, poor solid waste management emerged as a major issue in both datasets, with residents and informants alike identifying clogged canals and improper waste disposal as important contributors to flooding.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Finally, although communities possess some preparedness, adaptive capacity remains moderate, so strengthening disaster preparedness, institutional support, and community participation is essential. Collectively, the findings indicate the need for a comprehensive and sustainable drainage management strategy anchored on infrastructure improvement, environmental management, disaster preparedness, and community participation.

Table 11. **Joint Display of Quantitative and Qualitative Findings**

Domain	Quantitative result	Qualitative theme	Integration
Exposure	High exposure (M = 3.74); low elevation a strong cause (M = 4.02)	Theme 3: Vulnerability of low-lying communities	Convergent
Drainage condition	Moderately effective (M = 3.13); inadequate drainage a strong cause (M = 4.04)	Theme 1: Inadequate drainage infrastructure	Convergent
Solid waste	Clogged canals (M = 4.09) and poor SWM (M = 4.07) ranked 2nd and 3rd; low maintenance ratings	Theme 2: Solid waste management challenges	Convergent
Adaptive capacity	Moderate (M = 3.28); evacuation knowledge highest, government support lowest	Theme 4: Moderate disaster preparedness	Convergent; interviews explain uneven household preparedness
Governance	Multiple natural and human causes rated strong (overall M = 4.00)	Theme 5: Need for integrated flood management	Complementary; interviews point to coordinated, multi-sector response

Proposed Sustainable Drainage Management Plan (RQ6)

Based on the integrated findings, a Sustainable Drainage Management Plan was formulated with the goal of reducing flood vulnerability and strengthening community resilience through sustainable, climate-responsive, and community-based drainage management strategies in the flood-prone barangays of Palo, Leyte. Table 12 presents its strategic objectives, programs and activities, responsible offices, time frames, and performance indicators.

Table 12. **Proposed Sustainable Drainage Management Plan**

Strategic objective	Programs and activities	Responsible office(s)	Time frame	Performance indicator
Improve drainage capacity	Rehabilitation and widening of drainage canals	MEO	Short to medium term	Reduced floodwater accumulation

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

Enhance drainage maintenance	Regular declogging and desilting operations	MEO, barangays	Continuous	Improved drainage functionality
Strengthen solid waste management	Waste segregation campaigns and enforcement	SWMO, barangays	Continuous	Reduced canal blockage
Improve disaster preparedness	Flood drills and early warning systems	MDRRMO	Annual	Increased preparedness level
Promote community participation	Community-based flood monitoring	Barangays	Continuous	Increased stakeholder involvement
Enhance climate resilience	Climate-adaptive drainage planning	LGU, MEO	Medium to long term	Improved resilience indicators
Strengthen governance	Multi-sector Flood Management Council	LGU	Continuous	Improved coordination and policy implementation

Note. LGU = Local Government Unit; MDRRMO = Municipal Disaster Risk Reduction and Management Office; MEO = Municipal Engineering Office; SWMO = Solid Waste Management Office.

The plan prioritizes improving drainage capacity through the rehabilitation and widening of existing canals, led by the MEO over the short to medium term and measured by reduced floodwater accumulation in flood-prone areas. To sustain the functionality of drainage infrastructure, it provides for regular declogging and desilting operations jointly undertaken by the MEO and the barangays. Recognizing the contribution of improper waste disposal to flooding, it strengthens solid waste management through continuous waste segregation campaigns and enforcement of environmental regulations by the SWMO in partnership with the barangays, to reduce canal blockage and improve water flow.

The plan further improves disaster preparedness through annual flood drills and enhanced early warning systems under the leadership of the MDRRMO, to increase community preparedness before, during, and after flood events. Through community-based flood monitoring, barangays participate actively in flood risk monitoring and reporting, increasing stakeholder involvement and promoting shared responsibility. To address the long-term impacts of climate change, climate-adaptive drainage planning led by the LGU and the MEO aims to ensure that drainage infrastructure can withstand future climate-related hazards. Finally, a multi-sector Flood Management Council composed of representatives of the LGU, concerned government agencies, and community stakeholders is proposed to ensure continuous coordination and improve policy implementation, institutional collaboration, and the overall effectiveness of flood risk management.

Proposed Resilience-Building Framework

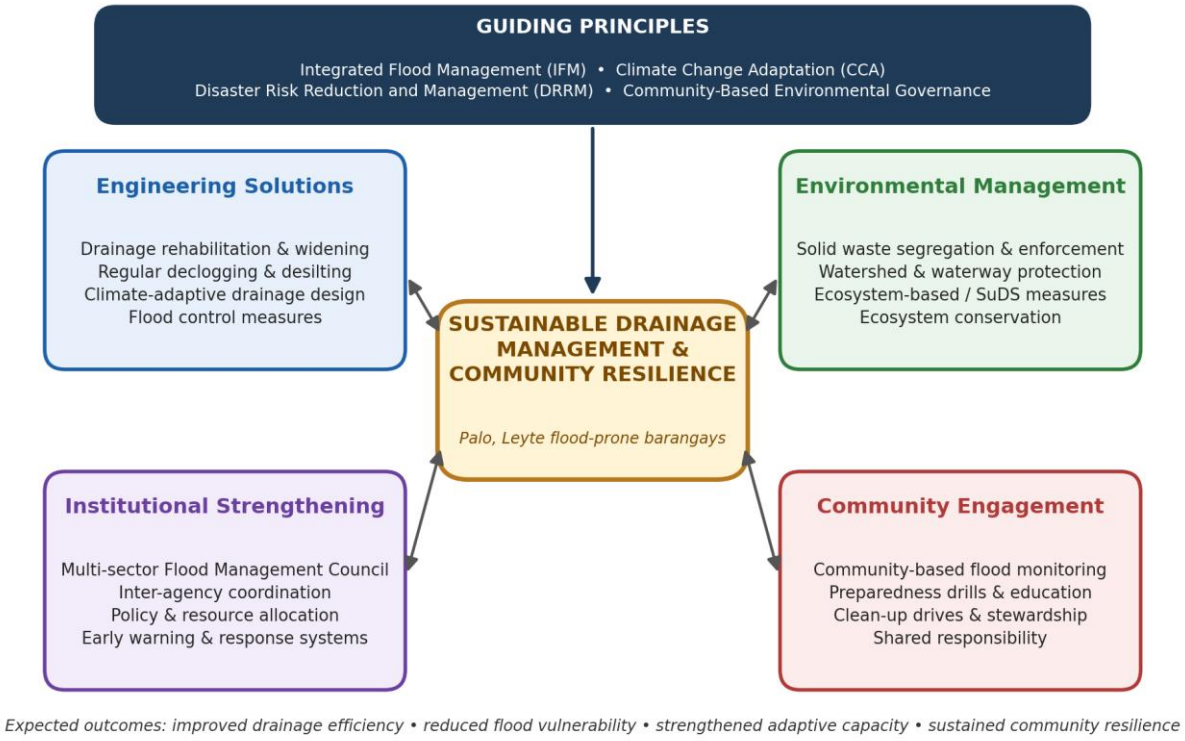
The plan is operationalized through a Resilience-Building Framework (Figure 2) anchored on the principles of IFM, Climate Change Adaptation (CCA), Disaster Risk Reduction and Management (DRRM), and Community-Based Environmental Governance. The framework comprises four interrelated components. *Engineering solutions* focus on improving drainage infrastructure and implementing effective flood control measures. *Environmental management* emphasizes watershed protection, proper solid waste management, and ecosystem

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

conservation. *Institutional strengthening* promotes effective policies, inter-agency coordination, and resource allocation. *Community engagement* encourages active public participation, preparedness, and environmental stewardship. By integrating these components, the framework seeks to enhance drainage efficiency, reduce flood vulnerability, strengthen adaptive capacity, and promote sustained community resilience, and it is intended to guide local government units, policymakers, and other stakeholders in developing long-term flood management strategies.

Figure 2. **Proposed Resilience-Building Framework**



© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

DISCUSSION

This study examined flood vulnerability, drainage system conditions, and perceived causes of flooding in flood-prone barangays of Palo, Leyte, and used the integrated findings to propose a Sustainable Drainage Management Plan. Overall, the results depict communities that are highly exposed and sensitive to flooding, possess only moderate capacity to adapt, and rely on a drainage system whose weaknesses—particularly in maintenance—are compounded by poor solid waste practices.

High Exposure and Sensitivity, Moderate Adaptive Capacity

The combination of high exposure (M = 3.74) and high sensitivity (M = 3.88) with only moderate adaptive capacity (M = 3.28) corresponds to the configuration that the IPCC vulnerability framework associates with elevated vulnerability (Adger, 2006; IPCC, 2023). The profile data help explain the exposure findings: more than half of the respondents lived in low-lying interior areas or near rivers and creeks, and nearly a quarter lived in light-material houses that are more susceptible to structural damage. The strong agreement that flooding disrupts children's schooling (M = 4.20) and livelihoods (M = 4.00) shows that the impacts of flooding extend well beyond physical damage to education, income, and health, consistent with views of vulnerability as rooted in social and economic conditions rather than in the hazard alone (Wisner et al., 2004).

The adaptive capacity results reveal a gap between awareness and institutional response. Residents generally knew their evacuation routes, suggesting that awareness programs mandated under the Philippine DRRM system (Republic Act No. 10121) have had some success, yet government support during floods and the effectiveness of barangay response measures were the weakest indicators. This pattern echoes Norris et al. (2008), who argued that resilience depends not only on individual knowledge but on networked capacities such as information flow, resources, and community competence, and is consistent with Garcia and Santos's (2022) finding that local government support shapes adaptive capacity in flood-prone Philippine communities. The informants' observation that preparedness varies among households (Theme 4) suggests that preparedness programs should be targeted toward the most sensitive households rather than delivered uniformly.

Drainage Performance and the Maintenance Gap

Residents rated the drainage system as only moderately effective (M = 3.13), and the dimension-level analysis shows that maintenance (M = 3.07) and capacity and design (M = 3.09) were weaker than functionality (M = 3.23). The lowest-rated item—regular cleaning of canals (M = 2.98)—indicates that the problem is not only one of insufficient infrastructure but also of how existing infrastructure is managed. Drainage performance depends on design capacity, hydraulic efficiency, and maintenance practices (Butler et al., 2018); when canals are not regularly cleaned and clogged sections are not promptly addressed, even adequately designed systems lose capacity. Informants' remarks that many canals were designed years ago and can no longer carry current runoff volumes (Theme 1) add a design-capacity dimension consistent with Santos and Cruz's (2021) findings for coastal municipalities in Eastern Visayas, where aging infrastructure, insufficient maintenance, and rising rainfall intensity combined to produce frequent flooding. These findings support a dual strategy of immediate maintenance improvement and longer-term capacity upgrading (Tingsanchali, 2012).

Interacting Natural and Anthropogenic Causes

Heavy rainfall and typhoons emerged as the most significant perceived cause of flooding (M = 4.20), indicating that respondents recognize intense precipitation from monsoon rains and tropical cyclones as the primary trigger of flood events. This is consistent with the IPCC (2023) conclusion that climate change has increased the frequency and intensity of extreme rainfall events, heightening flood risk in vulnerable communities, and with Palo's documented exposure to extreme typhoon impacts (Lagmay et al., 2015).

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

The second and third highest-rated factors were clogged canals due to garbage (M = 4.09) and poor solid waste management (M = 4.07), showing that respondents perceive improper waste disposal as a major human-induced driver of flooding. Accumulated solid waste obstructs canals, restricts stormwater flow, and reduces drainage efficiency, producing localized flooding during heavy rainfall. These findings support the observations of UN-Habitat (2021) and Lamond et al. (2012) that inadequate solid waste management impairs urban drainage and exacerbates flood hazards in developing countries, and they indicate persistent gaps in the local implementation of Republic Act No. 9003.

Respondents likewise identified an inadequate drainage system (M = 4.04) and the low elevation of the area (M = 4.02) as strong contributors, suggesting that existing infrastructure cannot accommodate increasing runoff while the municipality's low-lying topography heightens susceptibility. This is consistent with IFM principles, which recognize that both structural limitations and physical landscape characteristics influence flood occurrence (WMO, 2009). Lack of regular drainage maintenance (M = 3.94), overflow from rivers and creeks (M = 3.92), and rapid urbanization or building expansion (M = 3.73) received comparatively lower means but were still rated strong causes, indicating that flooding results from the interaction of natural hydrological processes and anthropogenic activities, including increasing impervious surfaces, inadequate maintenance of drainage facilities, and river overflow during intense rainfall.

Overall, respondents perceive flooding as a complex environmental issue arising from the combined effects of climate-related hazards, inadequate drainage infrastructure, improper solid waste management, unfavorable topography, and continuing urban development. These findings reinforce the IFM framework, which holds that effective flood risk reduction requires coordinated structural, environmental, and institutional interventions rather than reliance on engineering measures alone (WMO, 2009). They also fit the PSR Model (OECD, 1993): environmental *pressures* such as rapid urbanization and poor waste management degrade the *state* of drainage systems, increasing flood vulnerability and calling for coordinated *responses* from government and communities—the role the proposed plan is intended to fill.

Toward Integrated, Community-Based Drainage Management

The convergence of residents' and officials' perspectives—summarized in the informants' statement that flooding cannot be solved by drainage improvements alone—supports the central premise of IFM and the Sendai Framework that flood risk reduction requires shared responsibility across government levels and communities (UNDRR, 2015; WMO, 2009). The proposed plan therefore pairs structural measures (canal rehabilitation and widening, declogging, and climate-adaptive design) with non-structural measures (waste segregation and enforcement, early warning and drills, community-based monitoring, and a multi-sector Flood Management Council). Its inclusion of ecosystem-based and SuDS-type measures reflects international guidance that source-control approaches complement conventional conveyance and provide co-benefits for water quality and urban livability (ADB, 2023; Fletcher et al., 2015; Jha et al., 2012). Because maintenance and waste management—rather than design alone—emerged as key weaknesses, many of the plan's highest-impact actions are relatively low-cost and can be implemented through existing municipal and barangay structures.

Implications for Stakeholders

The findings provide evidence that the LGU of Palo can use to guide policy formulation, infrastructure investment, land-use planning, and flood mitigation programs. For the MEO, the item- and dimension-level results offer a basis for prioritizing drainage rehabilitation, maintenance, expansion, and infrastructure improvement. For the MDRRMO, the moderate adaptive capacity ratings support the enhancement of flood preparedness programs, early warning systems, emergency response plans, and resilience-building initiatives. For the SWMO, the strong link between waste and drainage blockage can inform waste management programs aimed at reducing flood risk. Barangay officials can use the findings to guide barangay-level community-based DRR and climate adaptation

© 2026 Advancing SDG Impact. All rights reserved.

programs; residents stand to benefit from improved flood management, enhanced preparedness, and reduced flood risk; and future researchers may use the study as a reference for work on flood vulnerability assessment, climate adaptation, sustainable drainage systems, and community resilience.

Limitations and Directions for Future Research

Several limitations should be considered when interpreting the findings. First, the study relied on residents' perceptions and did not include hydrological modeling, GIS-based flood mapping, engineering design computations, or cost–benefit analysis; perception-based ratings capture lived experience but should be complemented by physical measurements of drainage capacity and flood extent. Second, the analysis was descriptive, using weighted means of ordinal Likert data (Jamieson, 2004); differences across barangays, housing types, or locations were not tested inferentially. Third, sample size was determined using Slovin's formula, which does not account for population variability or desired confidence level and has been critiqued in the methodological literature (Tejada & Punzalan, 2012). Fourth, the qualitative strand involved eight key informants drawn from government offices and barangay leadership, so residents' voices were represented only through the survey. Finally, the findings pertain to selected barangays of a single municipality and should be generalized to other settings with caution. Future research should (a) conduct GIS-based flood hazard mapping to complement vulnerability assessments; (b) undertake hydrological and hydraulic modeling to evaluate drainage performance under various climate scenarios; (c) investigate the long-term effectiveness of sustainable drainage interventions and climate adaptation measures; and (d) examine the economic costs and benefits of the proposed drainage improvements.

CONCLUSIONS

The selected flood-prone barangays of Palo, Leyte, exhibit considerable flood vulnerability characterized by high exposure and sensitivity. Residents frequently experience flooding during heavy rainfall, with adverse effects on livelihoods, education, health, and property. Although communities demonstrate some preparedness and awareness, their adaptive capacity remains moderate, and existing disaster response systems, early warning mechanisms, and government support programs require enhancement to improve resilience against future flood events.

The current drainage systems are only moderately effective in managing stormwater runoff; infrastructure limitations, inadequate maintenance, insufficient capacity, and blockage reduce the effectiveness of existing flood control measures. Flooding in the study area results from the interaction of natural and anthropogenic factors: heavy rainfall and typhoons interact with improper waste disposal, inadequate drainage infrastructure, low-lying topography, and insufficient maintenance practices.

The perspectives of residents and key informants consistently indicate that flood management should not rely solely on engineering interventions. Effective flood risk reduction requires integrated approaches that combine infrastructure development, environmental management, institutional support, and community participation. Implementing the proposed Sustainable Drainage Management Plan, anchored on IFM principles, can contribute significantly to reducing flood risk, improving drainage performance, and strengthening community resilience in the flood-prone barangays of Palo, Leyte.

RECOMMENDATIONS

In view of the findings and conclusions, the following recommendations are proposed.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

For the Local Government Unit of Palo

- Develop and implement a comprehensive Municipal Flood Risk Reduction and Sustainable Drainage Management Program.
- Allocate adequate funding for drainage rehabilitation, expansion, and maintenance projects in flood-prone barangays.
- Strengthen inter-agency collaboration among the MEO, the MDRRMO, the SWMO, and barangay governments.

For the Municipal Engineering Office

- Conduct regular assessments of drainage infrastructure to identify areas requiring rehabilitation, upgrading, or redesign.
- Implement periodic canal declogging, desilting, and maintenance activities to improve drainage efficiency.
- Incorporate climate-resilient engineering designs in future drainage projects.

For the Municipal Disaster Risk Reduction and Management Office

- Strengthen flood early warning systems and improve the dissemination of hazard information.
- Conduct regular flood preparedness seminars, drills, and capacity-building activities.
- Develop community-based flood monitoring and reporting mechanisms.

For the Solid Waste Management Office

- Intensify waste segregation campaigns and strengthen enforcement of solid waste management regulations.
- Conduct regular clean-up drives and canal-clearing operations in collaboration with barangay officials and community organizations.
- Promote environmental awareness programs emphasizing the relationship between waste disposal and flooding.

For Barangay Officials

- Establish Barangay Flood Management Committees responsible for monitoring drainage conditions and coordinating flood preparedness activities.
- Encourage community participation in drainage maintenance and environmental protection programs.
- Develop localized flood contingency plans and evacuation protocols.

© 2026 Advancing SDG Impact. All rights reserved.

Volume 1 Issue 3 Pages 2503-2533

For Community Residents

- Practice proper waste segregation and responsible disposal of solid waste.
- Participate actively in flood preparedness activities, clean-up drives, and environmental programs.
- Support community-based flood monitoring and reporting initiatives.

For Future Researchers

- Conduct GIS-based flood hazard mapping to complement vulnerability assessments.
- Undertake hydrological and hydraulic modeling studies to evaluate drainage system performance under various climate scenarios.
- Investigate the long-term effectiveness of sustainable drainage interventions and climate adaptation measures.
- Explore the economic costs and benefits of the proposed drainage infrastructure improvements.

Acknowledgments

The researcher offers his highest praise and thanksgiving to Almighty God for His blessings, wisdom, strength, and guidance throughout this study. Heartfelt gratitude is extended to President Eunice T. Tudtud Pagatpat for her unwavering support, trust, and inspiring leadership; to Dr. Eleanor R. Chuca, Dr. Evangeline Jamili, and Dr. Maria Charito L. Suyom for their invaluable guidance, expertise, and constructive suggestions, particularly in developing and refining the research title and direction of the study; to Sir Lowe S. Taña for his support, encouragement, and assistance throughout the research process; and to Ms. Myrene Dela Pasion for her assistance and expertise in the statistical treatment and analysis of data, which helped ensure the accuracy and reliability of the findings.

Sincere thanks are also extended to the student assistants Angelyn Delfin, John Mike Dongsal, Aljor Saño, and Joaquin Duque for their invaluable help in data gathering, recording, and organizing research materials; to all respondents and key informants who willingly shared their time, experiences, and information, which formed the foundation of this study; and to the researcher's family, friends, and colleagues for their support, encouragement, prayers, and understanding.

© 2026 Advancing SDG Impact. All rights reserved.

JASDG
JOURNAL FOR THE ADVANCEMENT OF SUSTAINABLE DEVELOPMENT GOALS
Advancing Knowledge. Inspiring Innovation. Achieving the SDGs.
AN INTERNATIONAL, PEER-REVIEWED, OPEN ACCESS JOURNAL
www.jasdg.com
Volume 1 Issue 3 Pages 2503-2533

REFERENCES

Abon, C. C., David, C. P. C., & Pellejera, N. E. B. (2011). Reconstructing the Tropical Storm Ketsana flood event in Marikina River, Philippines. *Hydrology and Earth System Sciences, 15*(4), 1283–1289. https://doi.org/10.5194/hess-15-1283-2011

Adger, W. N. (2006). Vulnerability. *Global Environmental Change, 16*(3), 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Asian Development Bank. (2023). *Urban flood risk management in Southeast Asia: Building climate-resilient cities*. Asian Development Bank.

Birkmann, J. (Ed.). (2013). *Measuring vulnerability to natural hazards: Towards disaster resilient societies* (2nd ed.). United Nations University Press.

Braun, V., & Clarke, V. (2022). *Thematic analysis: A practical guide*. SAGE Publications.

Butler, D., Digman, C. J., Makropoulos, C., & Davies, J. W. (2018). *Urban drainage* (4th ed.). CRC Press.

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297–334. https://doi.org/10.1007/BF02310555

Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster resilience indicators for benchmarking baseline conditions. *Journal of Homeland Security and Emergency Management, 7*(1), Article 51. https://doi.org/10.2202/1547-7355.1732

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs—Principles and practices. *Health Services Research, 48*(6 Pt 2), 2134–2156. https://doi.org/10.1111/1475-6773.12117

Fletcher, T. D., Shuster, W., Hunt, W. F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., Barraud, S., Semadeni-Davies, A., Bertrand-Krajewski, J.-L., Mikkelsen, P. S., Rivard, G., Uhl, M., Dagenais, D., & Viklander, M. (2015). SUDS, LID, BMPs, WSUD and more—The evolution and application of terminology surrounding urban drainage. *Urban Water Journal, 12*(7), 525–542. https://doi.org/10.1080/1573062X.2014.916314

Garcia, M. A., & Santos, R. P. (2022). Community resilience and adaptive capacity in flood-prone communities in Central Luzon, Philippines. *Philippine Journal of Environmental Science, 15*(2), 45–62.

Hair, J. F., Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hallegatte, S., Green, C., Nicholls, R. J., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature Climate Change, 3*(9), 802–806. https://doi.org/10.1038/nclimate1979

Intergovernmental Panel on Climate Change. (2023). *Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC. https://doi.org/10.59327/IPCC/AR6-9789291691647

© 2026 Advancing SDG Impact. All rights reserved.

Jamieson, S. (2004). Likert scales: How to (ab)use them. *Medical Education, 38*(12), 1217–1218. https://doi.org/10.1111/j.1365-2929.2004.02012.x

Jha, A. K., Bloch, R., & Lamond, J. (2012). *Cities and flooding: A guide to integrated urban flood risk management for the 21st century*. World Bank. https://doi.org/10.1596/978-0-8213-8866-2

Lagmay, A. M. F., Agaton, R. P., Bahala, M. A. C., Briones, J. B. L. T., Cabacaba, K. M. C., Caro, C. V. C., Dasallas, L. L., Gonzalo, L. A. L., Ladiero, C. N., Lapidez, J. P., Mungcal, M. T. F., Puno, J. V. R., Ramos, M. M. A. C., Santiago, J., Suarez, J. K., & Tablazon, J. P. (2015). Devastating storm surges of Typhoon Haiyan. *International Journal of Disaster Risk Reduction, 11*, 1–12. https://doi.org/10.1016/j.ijdrr.2014.10.006

Lamond, J., Bhattacharya, N., & Bloch, R. (2012). The role of solid waste management as a response to urban flood risk in developing countries, a case study analysis. *WIT Transactions on Ecology and the Environment, 159*, 193–204. https://doi.org/10.2495/FRIAR120161

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology, 41*(1–2), 127–150. https://doi.org/10.1007/s10464-007-9156-6

Organisation for Economic Co-operation and Development. (1993). *OECD core set of indicators for environmental performance reviews: A synthesis report by the Group on the State of the Environment* (Environment Monographs No. 83). OECD.

Patton, M. Q. (2015). *Qualitative research and evaluation methods* (4th ed.). SAGE Publications.

Philippine Atmospheric, Geophysical and Astronomical Services Administration. (2024). *Flood monitoring and forecasting reports*. PAGASA.

Philippine Health Research Ethics Board. (2022). *National ethical guidelines for research involving human participants 2022*. Philippine Council for Health Research and Development.

Polit, D. F., & Beck, C. T. (2006). The content validity index: Are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health, 29*(5), 489–497. https://doi.org/10.1002/nur.20147

Republic Act No. 9003. (2001). *Ecological Solid Waste Management Act of 2000*. Congress of the Philippines.

Republic Act No. 10121. (2010). *Philippine Disaster Risk Reduction and Management Act of 2010*. Congress of the Philippines.

Republic Act No. 10173. (2012). *Data Privacy Act of 2012*. Congress of the Philippines.

Santos, J. M., & Cruz, E. P. (2021). Drainage infrastructure performance and urban flooding in selected municipalities of Eastern Visayas. *Philippine Planning Journal, 53*(1), 34–52.

Sekaran, U., & Bougie, R. (2020). *Research methods for business: A skill-building approach* (8th ed.). Wiley.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

© 2026 Advancing SDG Impact. All rights reserved.

Tejada, J. J., & Punzalan, J. R. B. (2012). On the misuse of Slovin's formula. *The Philippine Statistician, 61*(1), 129–136.

Tingsanchali, T. (2012). Urban flood disaster management. *Procedia Engineering, 32*, 25–37. https://doi.org/10.1016/j.proeng.2012.01.1233

United Nations Human Settlements Programme. (2021). *Urban resilience and waste management: Enhancing sustainable cities*. UN-Habitat.

United Nations Office for Disaster Risk Reduction. (2015). *Sendai framework for disaster risk reduction 2015–2030*. United Nations.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk: Natural hazards, people's vulnerability and disasters* (2nd ed.). Routledge.

World Meteorological Organization. (2009). *Integrated flood management: Concept paper* (WMO-No. 1047). World Meteorological Organization.

© 2026 Advancing SDG Impact. All rights reserved.