The 2nd International Conference on Disaster Risk Management for Strengthening Resilience and Sustainability in Communities 2026

ICDRM2026

Thaksin University

Abstract / Proceedings

Theme

"Integrating Disaster Management throughTransdisciplinary Approach via Disaster Platform to Develop from Resilience and Normality towards Anti-fragility"

ISBN (e-book) 978-974-474-116-5

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Message from the President
of Thaksin University

Warm greetings to you all, and a heartfelt welcome to the 2nd International Conference on Disaster Risk Management for Strengthening Resilience and Sustainability in Communities 2026 (ICDRM2026), held under the visionary theme: "Integrating Disaster Management through Transdisciplinary Approach via Disaster Platform to Develop from Resilience and Normality towards Anti-fragility."

As President of Thaksin University, I sincerely congratulate the conference organizing committee, our partners, and the Program Management Unit on Area-Based Development (PMU-A). Your hard work has successfully turned our local academic cooperation into a strong national disaster network.

Disasters and the intensifying climate crisis continue to present unprecedented structural and economic challenges globally and within Thailand. However, these crises also offer a pivotal opportunity to transform our approach. Thaksin University, with our strong goal to be a "Social Innovation University," is proud to serve as a bridge between advanced research and practical, local use. Through this conference, we proudly support moving from traditional "resilience" toward "anti-fragility," helping our local economies and communities grow even stronger through crises.

A key highlight this year is the collaboration of our university network across the country, working together as a transdisciplinary disaster platform. By combining advanced technologies with deep local wisdom, we are filling the gaps in current management structures. This important event is more than just an academic exchange; it serves as a real space to create useful policy recommendations and standard operating procedures (SOPs). These will protect people's lives and improve our nation's disaster security strategy to match the Sustainable Development Goals (SDGs).

On behalf of Thaksin University, the proud host at our Songkhla Campus, I would like to express my sincere gratitude to the distinguished international experts, researchers, presenters, and all onsite and virtual participants. I am fully confident that ICDRM2026 will serve as a transformative compass, turning high-impact research into tangible actions that drive long-term sustainability, security, and anti-fragile prosperity for society.

N. Chitniratna

Associate Professor Dr.Nathapong Chitniratna
President of Thaksin University

Message from Dean
of the Faculty of Nursing

It is my distinct honor and privilege to welcome distinguished guests, honored keynote speakers, esteemed colleagues, delegates, and participants to the 2nd International Conference on Disaster Risk Management: Strengthening Resilience and Sustainability in Communities 2026.

On behalf of the Faculty of Nursing, Thaksin University, and the organizing committee, I extend our warmest greetings to every participant — those joining us in person and those connecting with us online. This conference was conceived precisely to bring together those who are doing this work as researchers, policymakers, practitioners, civil society leaders, and communities on the frontlines of disaster risk.

I am confident that the conversations, insights, and collaborations that emerge from this conference will contribute meaningfully to safer, more resilient, and more sustainable communities — not only in our own regions, but around the world. I wish you all a most productive and rewarding conference.

Hathairat S.

Assistant Professor Dr. Hathairat Saengchan
Dean of the Faculty of Nursing

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The 2nd International Conference on Disaster Risk Management for Strengthening Resilience and Sustainability in Communities 2026 (ICDRM2026)

Theme "Integrating Disaster Management through Transdisciplinary Approach via Disaster Platform to Develop from Resilience and Normality towards Anti-fragility"

6-7 July 2026
at Prem Auditorium, Thaksin University, Songkhla Campus,
Mueang District, Songkhla Province

Monday, 6 July 2026

Time	Activities
08.00 - 08.45 a.m.	Registration of participants
09.00 - 10.00 a.m.	Performance for the Opening Ceremony by the Faculty of Fine and Applied Arts, Thaksin University
	Welcome Address by··· Associate Professor Dr. Nathapong Chitniratna President of Thaksin University
	Reported by··· Associate Professor Dr. Samak Kaewsuksaeng Vice President for Research and Innovation, Thaksin University
	Opening Address for "Southern Innovation Fair 2026" Under the theme: "Youth Power, Creativity, and Driving Sustainable Development Goals (SDGs)" by··· Dr. Wiparat De-ong Director of the National Research Council of Thailand (NRCT)
10.00 – 10.30 a.m.	Keynote Lecture: "Youth Power, Creativity, and Driving Sustainable Development Goals (SDGs)" by··· Dr. Wiparat De-ong Director of the National Research Council of Thailand (NRCT)
10.30 - 12.00 a.m.	Exhibition Tour: Disaster Management Technology and Innovation to Enhance and Elevate Community Capacity for Disaster Preparedness
12.00 - 13.00 p.m.	--- Lunch Break ---
Thailand Disaster Innovation Symposium 2026: From Resilience to Anti-fragility by Empowering National University Networks for Disaster-Ready Communities	
13.00 - 13.30 p.m.	The Role of Thaksin University in Disaster Management and Driving Area-Based Innovation to Elevate Communities for Sustainable Post-Crisis Growth by··· Dr. Suwat Wiriyapongsukit, M.D. Vice Chancellor Department of Medicine and Health Sciences
13.30 – 13.45 p.m.	The Role of Prince of Songkla University in Disaster Management and Driving Volunteer Networks and Humanitarian Support Systems to Strengthen Communities by... Prof. Dr. Narit Duangsuwan Director of the Volunteer Center, Prince of Songkla University

Time	Activities
13.45 – 14.00 p.m.	Best Practices in Disaster Management: IoT-Based Flash Flood Warning Systems and the Integration of the Thaksin University Shelter Network for Community Safety by… Assistant Professor Dr. Hathairat Sangchan Dean of the Faculty of Nursing, Thaksin University Dr. Napat Kaewphibal Assistant Dean for Digital and Corporate Communications, Faculty of Science and Digital Innovation, Thaksin University
14.00 – 14.15 p.m.	Best Practices in Disaster Management: Environmental Forecasting Technology and Hydrological Routing Models for Area-Based Early Warning Systems by... Assistant Professor Dr. Somporn Chuai-Aree Director of Office of Academic Resources, Prince of Songkla University, Pattani Campus
14.15 – 14.30 p.m.	Capacity Building for Local Administrative Organizations in Developing Community-Based Disaster Management Plans By... Dr. Vorasith Sornsrivichai Public Policy Institute, Prince of Songkla University, Hat Yai Campus
14.30 – 15.30 p.m.	Panel Discussion: "The Role of Community Representatives and Civil Society in Disaster Management: Driving Grassroots Network Mechanisms from Warning and Response Lessons to Sustainable Urban Recovery" by… 1. Petty Officer Second Class Komes Thongboonchoo Chairman of the Pa Community Disaster Warning Network Model (Koh Khan Sub-district, Cha-uat District, Nakhon Si Thammarat Province) under the Friends in Need (of "Pa") Volunteer Foundation, Thai Red Cross Society 2. Ms. Waeyoh Waenama, RN Professional Nurse, Emergency Room, Songklanagarind Hospital 3. Dr. Zakee Phithakkumpol Kuan Santi Mosque Community 4. Mr. Chakhrit Phochareong Manager of the Songkhla Community Foundation 5. Ms. Supaporn Sangchan Chairperson of the Chan Wirot Community, Hat Yai City Municipality, Songkhla Province
15.30 – 15.45 p.m.	The Role of the Government Sector in Disaster Management and Driving Emergency Response Strategies to Elevate the Safety and Sustainability of the Hat Yai Economic Zone by... Dr. Charintorn Phaettayananthawet Deputy Mayor of Hat Yai City Municipality, Songkhla Province
15.45 – 16.00 p.m.	The Role of the Government Sector in Disaster Management: Driving Proactive Measures and the Systematic Integration of Water Resources Management Plans in the Southern Region by… Office of the National Water Resources, Regional Office 4 (ONWR Regional Office 4)
16.00 – 16.30 p.m.	Sharing Student Volunteer Experiences: Integrating Interdisciplinary Collaboration to Unite and Support On-Site Emergency Response and Recovery for Disaster Victims by… Students from Faculty of Nursing, Faculty of Health and Sports Science, Faculty of Engineering and Faculty of Fine Arts, Thaksin University
16.30 - 17.00 p.m.	Visit the exhibition on disaster management technology and innovations that help strengthen and elevate communities' resilience in disaster response

Tuesday, 7 July 2026

Time	Activities	
08.00 - 08:30 a.m.	Registration	
08.30 – 09.00 a.m.	Keynote Speaker “Global Risk Awareness and Human-Made Disaster: How We Know, Prepare, and Live” by… Prof. Dr. Joanne Langan School of Nursing at Saint Louis University (SLU), USA.	
09:00 - 11:30 a.m.	Breakout Sessions for Research Presentations	
	Session	**Venue**
	1: Empowering Communities and Local Wisdom for Disaster Resilience	Room AO1, 1st Floor, Prem Auditorium
	2: Innovation and Transdisciplinary Disaster Platform for Achieving Anti-fragility	
	3: Climate Change Adaptation: Moving Beyond Normality for Sustainability	
	4: Governance and Policy Recommendation for Multi-Stakeholder Collaboration	Room AO2, 1st Floor, Prem Auditorium
	5: Innovation in Shelter Management and Humanitarian Support Systems in Fragile Border Contexts	
11:30 - 12:00 a.m.	Presentation on Disaster Management Summary of Key Knowledge and Insights	
12.00 -13.30 p.m.	--- Lunch Break ---	
13.30 p.m.	Closing Ceremony - Awarding certificates to outstanding research presenters - Closing Remarks by Associate Professor Dr. Samak Kaewsuksaeng Vice President for Research and Innovation of Thaksin University	

Oral Presentation Schedule

The 2nd International Conference on Disaster Risk Management for Strengthening Resilience and Sustainability in Communities 2026 (ICDRM2026)

Conference Theme: *Integrated Disaster Management Through an Interdisciplinary Disaster Platform: Advancing from Adaptation and the New Normal to Growth Through Crisis*

Date: 7 July 2026 | **Time:** 09:00–12:00 hrs.

Venue: Prem Music Hall, Thaksin University, Songkhla Campus, Mueang Songkhla District, Songkhla Province, Thailand

Room 1 (AO1), 1st Floor, Prem Music Hall

Theme: Smart Disaster Technology, Artificial Intelligence (AI), Climate Change, and Disaster Management

Panel of Experts

1. Dr. Worasit Sornsrivichai, MD
   Session Chair
2. Associate Professor Dr. Praditporn Pongtriang
   Session Committee Member
3. Assistant Professor Dr. Tassanee Sunthorn
   Session Secretary

Conference Observers

1. Paphawarin
   Master of Ceremonies (MC)
2. Wiriyaporn
   Timekeeper
3. Pensri
   Audio-Visual Support Officer
4. Wanicha
   Session Recorder
5. Lecturer Papha-on, RN
   Session Coordinator

Each presentation is allocated a total of 10 minutes: 7 minutes for the presentation and 3 minutes for questions and discussion. Remarks: *The presentation schedule is subject to change at the discretion of the Organizing Committee.*

Time	Title	Presenter	Theme
08.30-09.00	Global Risk Awareness and Human-Made Disaster: How We Know, Prepare, and Live	Prof.Dr. Langan (Online from the United States)	
09.00–09.10	From Warning to Action: A Conceptual Framework for Community Flood Preparedness in Hat Yai	Sirinon Suwanmolee	Flood
09.10–09.20	Development of a Prototype Decision Support System for Flood Disaster Shelter Management in Yala Province, Thailand	Solaeh Kepan, Sulaiman Persoh, Abdulloh Baka, Waesomsudin Waedorkor and Fudailah Duemong	Flood
09.20–09.30	Rescue Line: An AI-Powered LINE Chatbot for Flood Disaster Communication in Thailand	Setthawut Khiaokham, Mojtaba Safari	AI
09.30–09.40	Flood-Aware Logistics and Routing for Safe Mobility and Emergency Access	Mojtaba Safari	Logistics
09.40–09.50	Development of an IoT-Based Real-Time Flood Monitoring and Decision Support Platform for Area Development Manager Operations in Lampang Province, Thailand	Wanchai Khamsen et al.; Wiraya Datsang	IoT
09.50–10.00	Development of a Non-Contact Flood Monitoring System Using IP Camera and Image Processing Techniques	Jerawat Sopajarn et al.; Arrisa Sopajarn	Monitoring
10.00–10.10	An Integrated Web-Based Mapping and LoRa IoT System for Flash Flood	Naphat Keawpibal, Grit Tongkhundam, Visit	IoT

Time	Title	Presenter	Theme
	Monitoring and Vulnerable Population Support	Boonchom, Ajaree Naco, Noppamas Pukkhem	
10.10–10.20	Monitoring Mekong River Water Level using Image Processing and Internet of Things for Surveillance Applications	Seree Khunchai et al.; Bundit Boonkhao	IoT
10.20–10.30	Integrating Geographic Information System and Logistic Regression for Forest Fire Susceptibility Mapping in Chom Thong District, Chiang Mai Province, Thailand	Ratchaphon Samphutthanont and Worawit Suppawimut	GIS
10.30–10.40	Detection of Radon Anomalies for Earthquake Precursors Using Statistical and Machine Learning Methods: A Preliminary Study from the Mae Chan Fault Zone, Northern Thailand	Vitsanusart Atyotha, Ing-orn Sittitanadol, Nipada Papukdee, Khanuengnij Prakhammin	Earthquake
10.40–10.50	A Conceptual Framework for Climate Risk Management Integrating Sustainability Disclosure and Catastrophe Bonds: Implications for Thailand with International Evidence	Chih-Jen Wang	Climate
10.50–11.00	Climate Risks and Long-Term Well-Being in Thailand: A Comparative Regional Environmental Geography Analysis through the Sufficiency Economy Philosophy	Yi Qu, Jirasek Trimetsoontorn, Wang Kun Chen	Climate
11.00–11.10	A Methodological Framework Integrating Fuzzy Delphi, CFA, and SEM for Developing Disaster-Resilient Green Supply Chain Models under ESG Contexts	Yu-Ting Chen, Jirasek Trimetsoontorn, Yi Qu, Wang Kun Chen	ESG

Room 2 (AO2), 1st Floor, Prem Music Hall

Theme: Community Resilience, Disaster Nursing,
Public Health & Disaster Education

Panel of Experts

1. Professor Dr. Praneed Songwatthana
   Session Chair
2. Associate Professor Dr. Kantaporn Yodchai
   Session Committee Member
3. Lecturer Wipa Suwanrat, RN
   Session Secretary

Conference Observers

1. Piyawara
   Master of Ceremonies (MC)
2. Sarocha
   Timekeeper
3. Sakawarat
   Audio-Visual Support Officer
4. Paisol
   Session Recorder
5. Assistant Professor
   Punnaphat Chramnanpho, RN
   Technical Coordinator

Each presentation is allocated a total of 10 minutes: 7 minutes for the presentation and 3 minutes for questions and discussion. Remarks: *The presentation schedule is subject to change at the discretion of the Organizing Committee.*

Time	Title	Presenter	Theme
08.30-09.00	Global Risk Awareness and Human-Made Disaster: How We Know, Prepare, and Live	Prof.Dr. Langan (Online from the United States)	
09.00–09.10	Developing Systemic Management Mechanisms for Water Resource Management and Enhancing Competencies of Local Administrative Organizations and Water User Agencies: Lessons Learned	Jitraporn Somyanontanakul and Sirinon Suwanmolee	Community
09.10–09.20	The Effects of a School-Based Disaster Education Program in Improving Earthquake Preparedness among Junior High School Students in Indonesia	Junaidy Suparman Rustam, Aulia Putri, Fitrawatti	Education
09.20–09.30	Long-term Effects of Resilience and Coping Intervention on Self-Esteem Among Amphetamine Users	Kanchamon Sihapanya, Chuchart Wong-anuchit, Chanokchon Khotsombat	Resilience
09.30–09.40	Application of ADAPT-ITT Framework to Translate and Modify the Resilience and Coping Intervention (RCI) for Reducing Depression in Senior High School Students	Chanokchon Khotsombat, Santhat Phonchan, Choochart Wong-Anuchit	Education
09.40–09.50	The Thai Version of Resilience and Coping Intervention (RCI): Possibility and Suitability for Implementing in Thai Context	Choochart Wong-Anuchit, Chanokchon Khotsombat, Kanchamon Seehapanya	Resilience
09.50–10.00	Ethical Challenges Faced by Healthcare Professionals During the Phases of Flood Disaster Management: A Scoping Review	Omowale A. Odeyemi, Praneed Songwathana	Health
10.00–10.10	Enhancing Disaster Nursing Education Through Simulation-Based Learning: A Mass Casualty Incident Experience	Malee Kumkong, Punnaphat Chramnanpho, Mukkarin Thonghom, Krittaporn Sirisom, Janisa Namsai & Fursan Binsa	Nursing

Time	Title	Presenter	Theme
10.10–10.20	Experiences of Transformative Learning of Nursing Students Participating in Flood Disaster Relief During the 2025 Hat Yai Floods, Southern Thailand: A Qualitative Study	Maropi, Punnaphat Chramnanpho, Fursan Binsa, Athipong Muneeno, Hathairat Saegchan, Kittikorn Nilmanat, Samonnan Thasaneesuwan	Nursing
10.20–10.30	Validation and Reliability of the Nurses' Satisfaction with Nursing Practice in Promoting Patients' Spiritual Well-Being	Junaidy Suparman Rustam, Waraporn Kongsuwan, Samonnan Thasaneesuwan	Nursing
	During Hospitalization Tool (NSNP-PSWH Tool): A Preliminary Study		
10.30–10.40	Spatiotemporal Analysis and Socio-Climatic Factors of Leptospirosis in Trang, Thailand (2017–2024): Implications for Climate Change Adaptation and Anti-Fragile Health Systems	Soraya Tabtiang and Vorasith Sornsrivichai	Public Health
10.40–10.50	Smart Monitoring and Community Co-learning: AI-Enabled Disaster Awareness Enhancement for Global Resilient Communities	Yu-Ting Chen, Jirasek Trimetsoontorn, Ying-Lin Wang, Wang Kun Chen	Community
10.50–11.00	Bridging Traditional Knowledge and Modern Governance: A Framework for Strengthening Earthquake Resilience in Vanuatu	Ken Mana and Takaaki Kato	Governance
11.00–11.10	The Effect of Molding Condition on Properties of Natural Rubber Sponge for Life Jacket	Weerawut Naebpetch	Innovation
11.10–11.20	Growth Performance of Naked Neck and Thai Native Crossbred Chickens Reared under a Cage Production System	Supreya Thepparak, Saowanee Lekbangpong and Wisan Odton	Special Topic

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Thaksin University

Room 1 (AO1), 1st Floor, Prem Music Hall

Theme:

Smart Disaster Technology, Artificial Intelligence (AI), Climate Change, and Disaster Management

Enhancing Local Capacity in Community-Based Disaster Management Planning via 9 Community Disaster Tools and 8-System Disaster Management

Vorasith Sornsrivichai[1]*, et al.[2]

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2 The Academic Working Group on Enhancing the Capacity of Local Administrative Organizations to Develop Community-Based Disaster Management Plans; cbdrmpsu@gmail.com
*** Correspondence: vorasith@gmail.com; (Sornsrivichai V.)**

Abstract: Amidst the "Global Boiling" crisis, Thailand's Local Administrative Organizations (LAOs) face significant management gaps, particularly in translating national policies into actions that align with local "cultural ecology". This paper details a capacity-building initiative for 30 southern Thai communities at the subdistrict level, centered on Community-Based Disaster Risk Management (CBDRM) to bridge these gaps. The methodology utilizes a five-module curriculum focusing on "9 Community Disaster Tools" such as community disaster management mapping, a disaster calendar, and community asset tables to analyze local social capital and establish household-level databases for vulnerable groups through integrated information systems. These efforts lead to the creation of a unified "8-System Disaster Management" framework, encompassing a frontline incident command center, volunteer networks, and three-way communication. The primary output is a comprehensive three-phase disaster management plan (pre-disaster preparedness, disaster response, and post-disaster recovery) operationalized through integration into local ordinances and local health security fund budgets. By establishing multi-stakeholder integrated collaboration across government, academic, and civil sectors, this project facilitates a strategic paradigm shift from "Passive Relief" to "Proactive Self-Management". Ultimately, this systematic approach fosters sustainable resilience and anti-fragility, allowing communities to build back better and thrive after disaster.

Keywords: community-based disaster risk management; disaster management plan; community disaster tools; 8-system disaster management framework; cultural ecology; local administrative organization; global boiling; resilience; anti-fragility

From warning to action: A conceptual framework for community flood preparedness in Hat Yai

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Abstract: Urban flooding exposes not only the physical impacts of inundation but also the institutional and community-level failures that prevent early warnings from being translated into timely protective action. The 2025 Hat Yai flood illustrates this challenge, as severe losses were shaped by delayed preparedness activation, weak shared situational awareness, communication breakdowns, and emergency access constraints. This conceptual paper develops a community-centered framework for strengthening flood preparedness in dense urban settings by drawing on literature on multi-hazard early warning systems, emergency logistics, situation awareness, risk communication, and interagency coordination, together with documented lessons from the 2025 Hat Yai flood. A structured narrative synthesis was used to define the warning-to-action gap, group the literature into five analytical streams, extract key concepts, compare them with the Hat Yai response-system timeline, and integrate the findings into a three-gap diagnosis and preparedness pathway. The results show three interacting preparedness gaps: fragmented information was not converted into a shared operational picture; emergency mobility and access were insufficiently planned for disrupted urban conditions; and warning communication was weakly linked to inclusive, feasible protective action. The paper proposes a pathway linking early warning, community emergency response plans, inclusive protection, and anticipatory action. Practically, local governments should translate warnings into trigger-based community plans, core information standards, fallback communication, protected access routes, early shelter activation, and prioritized support for vulnerable groups. Future research should pilot and compare this pathway across flood-prone cities to assess its transferability and implementation requirements.

Keywords: Hat Yai urban flood preparedness; early warning systems; community emergency response plans; inclusive protection; anticipatory action

Development of a Prototype Decision Support System for Flood Disaster Shelter Management in Yala Province, Thailand

Solaeh Kepan[1], Sulaiman Persoh[2], Abdulloh Baka[3], Waesomsudin Waedorkor[4] and Fudailah Duemong[5*]

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Abstract: Yala Province in southern Thailand faces recurring flood disasters of significant scale, with recent events affecting up to 160,000 residents across all eight districts and 45,000 households, placing considerable strain on local disaster response capacity. Current shelter management relies on fragmented, manual processes that impede timely decision-making and equitable resource allocation during crises. This study employed the Structured Systems Development Life Cycle (SDLC) to develop a prototype decision support system (DSS) for flood disaster shelter management. Requirement analysis was conducted with key stakeholders including Local Administrative Organization (LAO) officials, shelter coordinators, healthcare personnel, and community volunteers. The system was designed with an integrated Geographic Information System (GIS) component to support location-based shelter coordination. The prototype is a web-based platform comprising seven functional modules, ranging from user management and victim registration to GIS-based mapping and a real-time decision dashboard, supported by an eight-table relational database. Initial deployment captured data from 69 shelters, 8 medical facilities, and 182 registered system users across Yala Province, confirming operational feasibility. The prototype demonstrates functional alignment with real-world shelter management workflows and fills a practical need for locally adapted, culturally sensitive digital tools for disaster response in Thailand's southern border communities. Expert evaluation, usability testing, and real-world implementation are planned as the next phase.

Keywords: flood disaster; decision support system; shelter management; GIS; system development; cultural sensitivity; southern Thailand

1. Introduction

Flood disasters rank among the most frequent and economically destructive natural hazards worldwide, affecting millions of people each year and placing considerable strain on emergency management systems. In developing countries, where local administrative capacity and digital infrastructure for disaster response remain limited, these pressures are especially pronounced [1, 2]. Among the most demanding aspects of flood response is the management of temporary evacuation shelters. Coordinators must quickly decide how to allocate limited resources, track available capacity across sites, and register displaced residents. In practice, these decisions are made with incomplete information and little time to deliberate [3, 4]. Yet this function has received comparatively little investment in digital tools, particularly at the local government level.

Yala Province in southern Thailand illustrates these challenges clearly. Situated within the Pattani River basin and bordered by mountainous terrain, the province faces recurring flash floods intensified by climate change and ongoing environmental degradation, including deforestation and unregulated encroachment along riverbanks [5]. The scale of recent events has been substantial: floods have inundated all eight districts simultaneously, affecting over 160,000 residents [6] and 45,000 households [7], while satellite analysis confirmed that southern Thailand experienced approximately 0.45 million rai of flood inundation in 2024 alone [8]. The province's high proportion of low-income households compounds these impacts: when floods destroy assets and livelihoods, families already living close to the poverty line can quickly lose the gains they have made over years of economic progress [9].

Shelter management in Yala Province relies on largely manual and fragmented processes, a pattern consistent with arrangements observed across Southeast Asia [3, 10]. Victim records are maintained separately by different agencies without any unified registry, capacity tracking depends on informal telephone coordination between sites, and resource distribution lacks systematic criteria for prioritizing the most vulnerable households. These conditions push disaster response toward reactive crisis management rather than coordinated planning, reducing both the speed and the fairness of humanitarian assistance [1].

Decision Support Systems (DSS) offer a promising path forward. By bringing together spatial hazard data, resource inventories, and population vulnerability profiles into a single operational platform, DSS can help emergency managers shift from improvised responses to more structured, evidence-informed decision-making [1, 2, 11]. Geographic Information Systems (GIS) play a central role in this architecture, enabling real-time visualization of hazard zones, shelter locations, and evacuation routes [1]. Research in Southeast Asia supports the practical value of this approach. For instance, Mabahwi and Nakamura [12, 13] found that 21% of existing flood shelters in Kuantan, Malaysia, were in sites with significant physical limitations, highlighting the importance of systematic spatial assessment. Community-level studies have similarly shown that locally adapted information systems meaningfully improve the ability of rescue teams and LAO officials to make timely decisions about resource allocation [3].

What is largely absent from the literature, however, is practical guidance for implementing DSS at the community level. Few platforms have been designed specifically for sub-district and local administrative organizations (LAOs) operating with limited technical capacity and context-specific constraints [3, 12]. Generic platforms developed for national or international humanitarian operations rarely accommodate the requirements of community-level shelter management. In Thailand's southern border provinces, this gap is especially consequential. Yala Province has a predominantly Muslim population, and effective shelter management requires attention to cultural practices that generic systems do not address [10]. These include gender-segregated spatial arrangements, halal food logistics, and culturally appropriate registration procedures. When digital systems fail to reflect these realities, they risk generating friction with the communities they are meant to serve. This is particularly consequential during active disaster response, when trust and smooth coordination matter most.

Existing digital tools for flood disaster response fall into two broad categories, neither of which adequately serves Yala Province's operational context. The first category comprises large-scale national and international humanitarian information systems, which are designed for cross-agency coordination at the provincial or national level and typically lack the granular, shelter-level functionality (such as real-time bed capacity tracking or individual victim registration) that LAO officials and shelter coordinators require for day-to-day operations [1, 2, 11]. The second category consists of GIS-based spatial assessment tools, such as those used by Mabahwi and Nakamura [12, 13] to evaluate shelter site suitability; while valuable for pre-disaster planning, these tools function as static assessment instruments rather than operational decision support platforms, and they offer no mechanism for managing victim registration, resource allocation, or real-time capacity during an active flood event. Critically, neither category of solution incorporates the cultural and religious considerations (gender-segregated spatial arrangements, halal food logistics, and culturally appropriate registration procedures) that are essential for shelter management in Yala Province's predominantly Muslim communities [10]. This leaves a clear gap: no existing system integrates real-time operational shelter management with GIS-based spatial coordination while remaining adapted to the technical capacity constraints of LAOs and the cultural context of Thailand's southern border provinces. Addressing this gap requires a purpose-built prototype rather than adaptation of existing platforms, since the operational, technical, and cultural requirements identified above are interdependent and cannot be retrofitted onto systems designed for different contexts and scales.

To address these needs, this study reports on the design and prototype development of a web-based decision support system for flood shelter management in Yala Province, conducted under the Yala Rajabhat University (YRU) strategic research program for poverty alleviation and disaster resilience [9]. The system integrates GIS with a multi-module shelter management platform intended to support decision-making across administrative levels, from provincial coordination down to individual shelter operations.

The study pursues three objectives:

1) To analyze the requirements for a DSS supporting flood shelter management in Yala Province through structured stakeholder engagement;

2) To design and develop a prototype web-based DSS integrating GIS for real-time shelter management during flood disaster response;

3) To demonstrate the prototype's functional feasibility and alignment with operational shelter management workflows in Yala Province.

The remainder of this paper is organized as follows: Section 2 describes the research methodology; Section 3 presents the prototype system design and key features; Section 4 discusses contributions and limitations; and Section 5 concludes with directions for future research.

2. Materials and Methods

This section describes the methodological procedures used to develop the prototype DSS for flood disaster shelter management in Yala Province, Thailand. The study followed a system development-oriented research approach, combining stakeholder requirement analysis, system design, prototype development, and preliminary testing. Throughout each phase, the aim was to ensure that the system reflected real operational conditions and could support informed decision-making during flood events.

2.1 Research Approach

System development followed the Structured Systems Development Life Cycle (SDLC) framework to ensure structured progress and effective GIS integration [14]. The process comprised three sequential phases: requirement analysis and specification, system design, and prototype development with preliminary testing.

2.2 Study Context and Stakeholder Identification

The system targets Yala Province, Thailand, serving personnel responsible for shelter management during flood events. Stakeholder groups were identified through the requirement analysis phase and encompass five categories: provincial and district LAO officials, temporary shelter coordinators, healthcare facility personnel, community-level volunteers and disaster relief network members, and provincial emergency management administrators. Together, these groups cover the full range of roles from provincial command to day-to-day shelter operations.

2.3 Requirement Analysis

Requirement analysis was conducted through two structured activities, selected to capture both policy-level and operational-level perspectives on flood shelter management. Participants across both activities were identified through purposive sampling, with eligibility based on each individual's institutional role or operational responsibility in flood disaster response or shelter coordination within Yala Province. Recruitment was carried out through two parallel channels: formal coordination through official government correspondence with provincial and local administrative agencies, and direct engagement through the research network of Yala Rajabhat University (YRU), which facilitated access to community-level coordinators and partner institutions.

The first was a focus group session held at Yala Rajabhat University, bringing together 162 participants from five stakeholder groups: provincial-level officials from the Yala Provincial Disaster Prevention and Mitigation Office; representatives of 11 Local Administrative Organizations (LAOs), comprising sub-district administrative organizations (SAOs) and sub-district municipalities (n = 35); local governance authorities including a Kamnan and village-level officers (n = 4); shelter coordinators from nine sub-districts (n = 95); and disaster response network members from partner universities and project staff (n = 28). This session was designed to elicit policy-oriented and administrative perspectives, drawing on participants' province-wide and inter-agency vantage point to identify systemic requirements for shelter coordination and resource allocation.

The second activity involved field visits to seven sub-districts of Mueang Yala District, conducted during flood preparedness meetings co-chaired by the Deputy Governor of Yala Province. A total of 480 participants attended across seven sessions, representing agencies including the Yala Provincial Disaster Prevention and Mitigation Office, the Yala Meteorological Station, the Bang Lang Dam Electrical Division, the Yala Irrigation Project, sub-district health-promoting hospitals, LAO representatives, the Yala Provincial Police, and special task military units operating in the area. Whereas the focus group session captured province-wide administrative priorities, these field visits were intended to ground-truth requirements against the operational realities of frontline responders and sub-district-level actors, ensuring that the resulting requirement set reflected day-to-day implementation conditions rather than administrative perspectives alone. The breadth of specialized agencies involved (e.g., irrigation, meteorological, security, and emergency medical services) reflected the multi-sectoral coordination demands inherent in flood shelter operations in the study area.

Discussions across both activities focused on operational challenges encountered during the November 2024 flood, covering shelter coordination, victim registration, resource allocation, and inter-agency communication. Data were collected through structured field notes recorded by the research team during both the focus group session and the field visits, supplemented by structured survey forms distributed to participants to capture operational details and stakeholder priorities that were not fully addressed verbally during discussions. The collected data were analyzed thematically in three stages. First, field notes and survey responses from both activities were reviewed line by line and assigned descriptive codes representing discrete operational issues raised by participants (e.g., "lack of real-time shelter capacity data," "absence of standardized victim registration," "need for gender-segregated shelter zones"). Second, codes that reflected related underlying concerns were grouped into broader categories through iterative comparison across the two data sources, allowing requirements identified during the focus group to be cross-checked against those emerging from the field visits. Third, these categories were consolidated into four overarching requirement domains, reflecting the core functional areas that the prototype system would need to address. To verify the accuracy and completeness of this analysis, the consolidated domains and their associated requirements were returned to a subset of participating stakeholders for member checking, allowing them to confirm that the identified domains accurately reflected the operational challenges they had raised. The four resulting requirement domains are summarized in Table 1.

Table 1. Requirement Analysis Summary

Domain	Key Requirements
Population, user & shelter data	CRUD functions for all entities; open/close status management for shelters and hospitals
Disaster spatial data	Spatial (geocoordinate) and attribute data for shelter/facility mapping; GIS layer integration
Reporting & dashboard	Real-time KPIs: shelter occupancy, capacity utilization, assistance request status, population demographics
Cultural & contextual fit	Alignment with Islamic practices (gender separation, halal food); inclusive access for minority groups

2.4 System Design

The system design addressed four major components: database design, state diagram, UI/UX design, and GIS integration. The design approaches for each component are summarized in Table 2.

Table 2. System Design Components

Design Component	Approach
Database design	Relational schema (8 tables) accommodating GIS attribute data and poverty household records
State diagram	Formal specification of DSS state transitions covering shelter lifecycle and user workflows
UI/UX design	Dashboard and reporting interfaces prioritizing real-time data display for crisis decision-making
GIS integration	Module for collecting, updating, and visualizing spatial data for hazard zones and facility locations

3. Results and Discussion

This section presents the main outputs of the prototype DSS development, organized according to the three phases of the research process introduced in Section 1: requirement analysis, prototype design and development, and implementation with preliminary findings. Building on the requirement analysis phase, which yielded four requirement domains spanning population and shelter data management, spatial data integration, real-time reporting, and cultural and contextual fit (Section 2.3, Table 1), the discussion begins with an overview of the system's overall structure and functions, followed by the database design and use case architecture that underpin data organization and user interactions. Together, these components constitute the prototype design and development stage. The system modules and prototype screens are then described to illustrate how the proposed DSS was implemented in practice. The section concludes with preliminary findings on the prototype's potential to support flood disaster shelter management across relevant stakeholder groups, representing the implementation phase of the research process.

3.1. Prototype System Overview

The resulting prototype is a web-based platform designated "Information System for Disaster Decision Support, Yala Province." The system was developed using PHP and JavaScript with the Laravel framework, a MySQL relational database, and Google Maps API for GIS integration. The frontend was built with HTML/CSS, Bootstrap, and Tailwind CSS to ensure responsiveness across devices. The system is publicly accessible and deployed on the Yala Rajabhat University server at https://disaster.yru.ac.th/.

Access is governed by role-based control across six user levels, ranging from provincial administrators to shelter-level staff, with each level restricted to the data and functions relevant to its operational role.

3.2. Database Design

The system's data architecture is illustrated in the entity-relationship (ER) diagram (Figure 1), comprising eight interrelated tables designed to cover the full range of shelter management operations. Three core tables manage foundational data: user accounts (*users*), hierarchical administrative area classification (*areas*), and shelter facility records including geographic coordinates and capacity information (*markers*).

Victim management relies on two tables: household intake records (*registrations*) and occupancy tracking with check-in and check-out timestamps (*date_of_stays*). Resource coordination draws on a pair of linked tables that handle humanitarian assistance requests submitted through the system (*assistance_requests*) and corresponding offers matched to outstanding needs (*assistance_offers*). A final table records shelter operational status with timestamps, capturing opening and closure events across the disaster response period (*date_of_markers*).

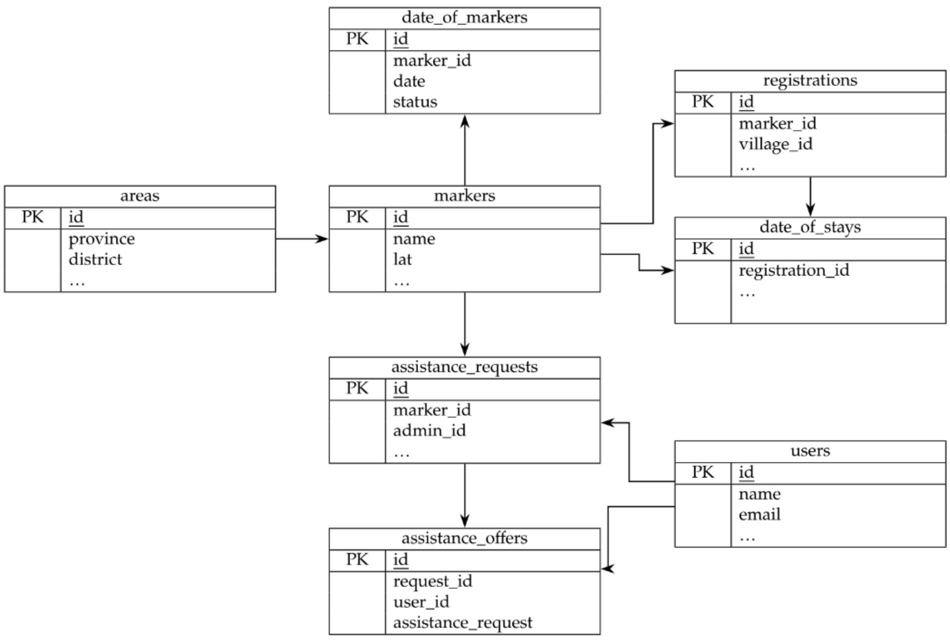

Figure 1. Entity-Relationship (ER) diagram of the prototype DSS database

3.3. *Use Case Architecture*

The use case diagram (Figure 2) identifies two primary actor groups, namely system administrators and disaster network representatives, operating across six administrative roles. Ten primary use cases were defined to address the core functions of shelter management during disaster response, ranging from system administration and disaster area management to victim registration, resource coordination, GIS map display, and operational reporting. The complete list of use cases is shown in Figure 2.

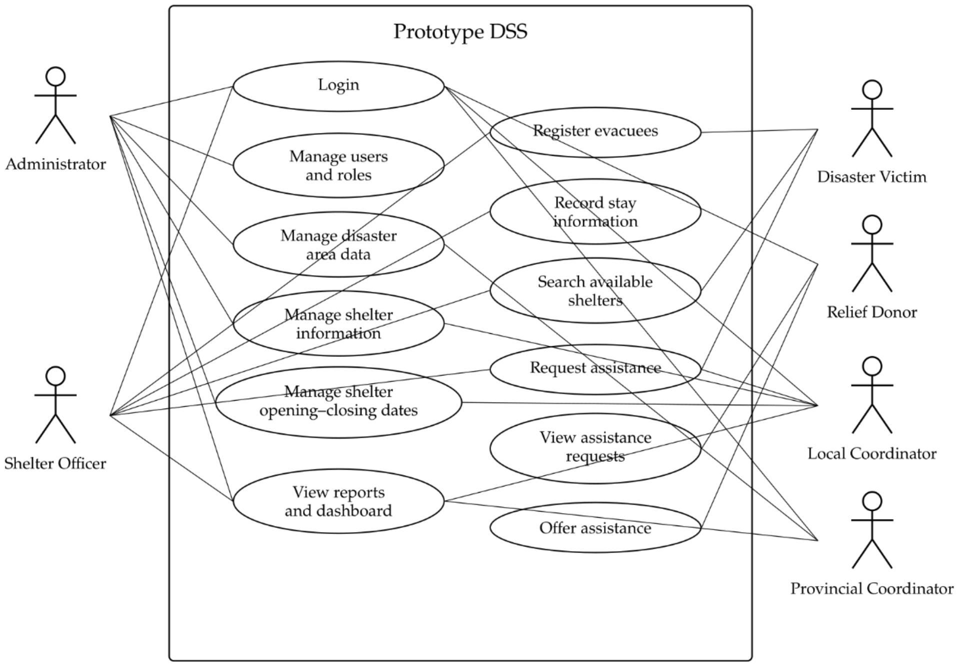

Figure 2. Use case diagram of the prototype DSS

3.4. *System Modules and Prototype Screens*

The prototype DSS was implemented through seven functional modules designed to support flood disaster shelter management. These modules cover user management, disaster area management, shelter information management, medical facility management, victim registration management, GIS-based mapping, and a real-time decision dashboard. Working together, the modules provide a unified environment for managing and visualizing disaster-related data to support shelter coordination during flood events.

The data management modules handle the core record-keeping functions of the system. User management supports role-based access control for 128 users across different administrative levels, while disaster area management records 27 affected areas with filtering options by province, district, and sub-district. Shelter information management stores data on 69 temporary shelters, covering location, responsible officers, capacity, and operational status. Medical facility management records 8 coordinated hospitals and health centers. The victim registration module rounds out this group, managing records of affected individuals including shelter assignments, length of stay, and household-level information.

The prototype also includes two components more directly oriented toward decision support. The GIS-based mapping module visualizes shelter locations and medical facilities as geo-referenced markers on a map of Yala Province, allowing users to assess the spatial distribution of available shelters and nearby support facilities. The real-time decision dashboard provides a consolidated view of key operational indicators, including the number of shelters, open shelter status, total capacity, current occupancy, assistance request status, vulnerable population groups, and registered disaster victims. These two components move the system beyond record-keeping toward active support for monitoring and coordination during flood response.

Rather than presenting all routine CRUD interfaces, this section focuses on the prototype screens that best illustrate the system's decision-support capabilities. The dashboard screen demonstrates how the system summarizes real-time operational data, while the GIS map screen showcases its spatial visualization capability. The remaining modules are summarized in Table 3 according to their main functions and decision-support contributions.

Table 3. Functional modules of the prototype DSS and their decision-support contributions

Module	Main function	Decision-support contribution
User management	Manages system users and role-based access	Controls access according to administrative responsibility
Disaster area management	Records disaster-affected areas and disaster status	Supports monitoring of active disaster areas
Shelter information management	Manages shelter location, capacity, and operational status	Supports shelter allocation and capacity planning
Medical facility management	Records hospitals and health centers	Supports referral and healthcare coordination
Victim registration management	Records affected persons and shelter stay information	Supports targeted assistance and population tracking
GIS-based mapping	Visualizes shelters and medical facilities on a map	Supports spatial assessment and location-based decisions
Real-time decision dashboard	Summarizes operational indicators	Supports rapid monitoring and decision-making

The real-time decision dashboard provides a consolidated view of the shelter situation in a single interface. As shown in Figure 3, the dashboard displays key operational indicators including shelter availability, open shelter status, total capacity, current occupancy, assistance request status, vulnerable population groups, and registered disaster victims. This enables shelter coordinators and provincial administrators to monitor the overall situation at a glance and respond to emerging needs without navigating multiple data sources.

The prototype also includes a GIS-based mapping interface that adds a spatial dimension to shelter coordination. As shown in Figure 4, shelter locations and medical facilities are displayed as geo-referenced markers on a map of Yala Province. Users can view the distribution of available shelters across the affected area and identify nearby health facilities, supporting more informed decisions about shelter assignment and resource deployment.

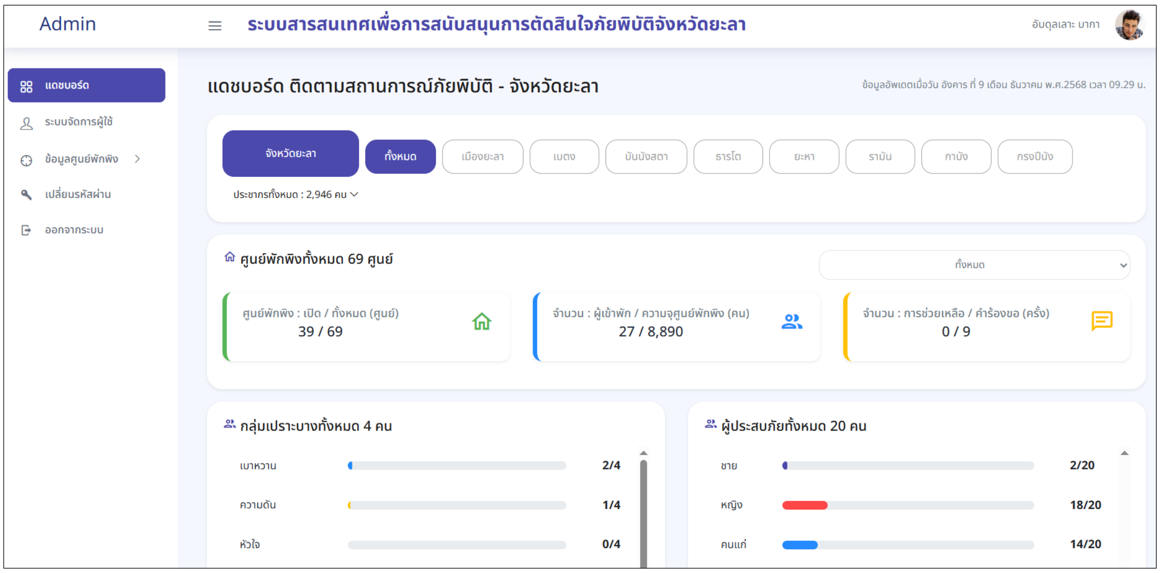

Figure 3. Real-time decision dashboard of the prototype DSS

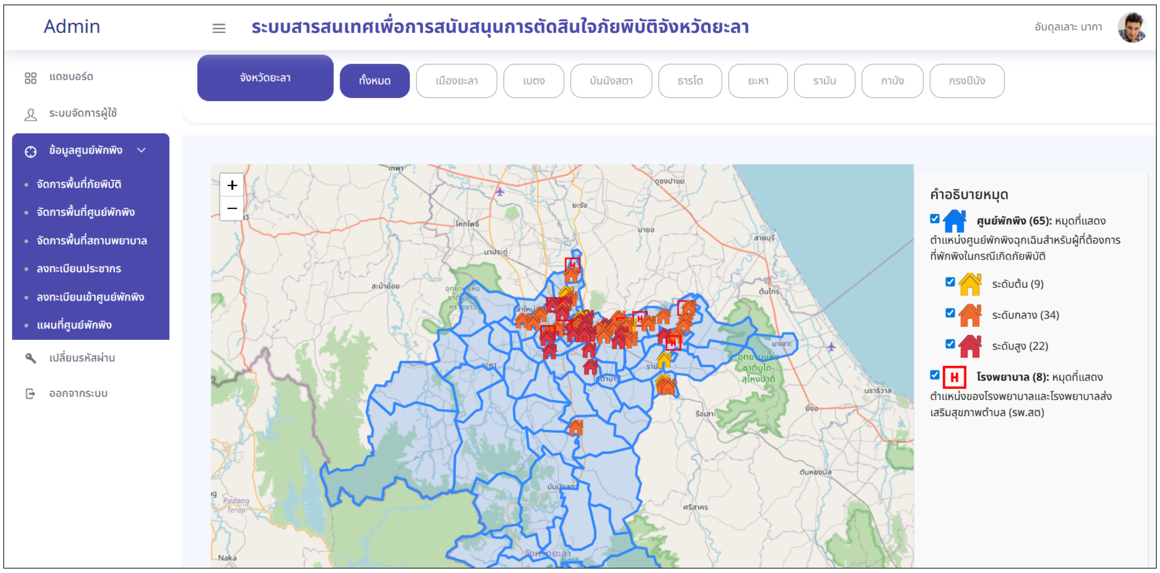

Figure 4. GIS-based mapping interface for shelter and medical facility visualization

3.5. Preliminary Findings

The prototype deployment captured authentic provincial data, including 69 geocoded shelters, 8 medical facilities, and 182 system users across multiple administrative levels, confirming that the platform has moved beyond conceptual design to a functional system operating with actual field data.

A preliminary stakeholder training session was conducted at Yala Rajabhat University, with 164 LAO officials and shelter coordinators representing 11 sub-districts participating. Participating organizations included both sub-district administrative organizations (SAOs) and sub-district municipalities across Mueang Yala District: Wangphaya SAO, Arson SAO, Tha Thong SAO, Tase SAO, Phron SAO, Na Tham SAO, Balo Municipality, Tha Sap Municipality, Budi Municipality, Sateng Nok Town Municipality, and Yupo Municipality. The session confirmed that participants were able to operate the system's core modules, including victim registration, GIS-based shelter mapping, and the real-time dashboard, and that the system workflow aligns with existing shelter management procedures at the sub-district level.

Internal review by the development team further confirmed functional alignment with shelter management workflows currently practiced by LAO officials in Yala Province. Three features were identified as directly addressing documented operational gaps: (1) real-time occupancy monitoring, replacing phone-based coordination; (2) integrated GIS mapping, eliminating manual shelter tracking; and (3) the assistance request matching module, enabling targeted delivery of aid to be registered households linked to poverty vulnerability data.

3.6. Discussion

The findings of this study are discussed in relation to the three research objectives outlined in Section 1: requirement analysis through stakeholder engagement, prototype design and development with GIS integration, and demonstration of functional feasibility and operational alignment. Limitations of the current prototype are then addressed.

3.6.1 Requirement Analysis: Triangulating Policy and Operational Perspectives A key finding from the requirement analysis phase is that the two structured data collection activities, the focus group session at Yala Rajabhat University and the field visits across seven sub-districts, captured meaningfully different but complementary perspectives on shelter management needs. The focus group, dominated by provincial-level officials and inter-agency network representatives, surfaced systemic and administrative priorities such as standardized data governance and cross-agency reporting. The field visits, conducted with frontline responders and sub-district-level actors during active flood preparedness meetings, surfaced operational priorities grounded in day-to-day implementation conditions, such as the practical difficulty of tracking shelter capacity by phone. The convergence of both data sources on the same four requirement domains (Table 1) suggests that these domains reflect genuine, cross-validated operational needs rather than the priorities of a single stakeholder group, lending greater credibility to the requirement set that subsequently informed the system design.

3.6.2 Prototype Design and Development: GIS Integration and Localized Data Architecture The prototype's design directly operationalizes the requirement domains identified in the analysis phase. The integration of Google Maps API-based GIS functionality within the dashboard and mapping modules (Section 3.4) addresses the spatial data domain, enabling shelter coordinators to visualize the distribution of available shelters and medical facilities in real time, a capability identified as absent in the manual, phone-based coordination previously used in the province.

A further contribution lies in linking shelter management data with YRU's existing poverty household database (PPAP). This integration allows humanitarian assistance to be directed systematically toward households already identified as vulnerable, helping to close the gap between disaster relief logistics and broader social protection efforts [2]. This design choice also reflects the cultural and contextual fit requirement domain: the system incorporates specific accommodations for Islamic cultural practices, including gender-segregated shelter arrangement data, halal food logistics tracking, and inclusive minority-group registration, directly reflecting the operational realities of Yala Province's multicultural communities [7]. Unlike generic disaster management platforms, which do not accommodate these considerations, the prototype was designed from the outset to incorporate them as core system requirements rather than later additions.

3.6.3 Feasibility and Operational Alignment

Compared to existing regional and international shelter management systems, this prototype targets the sub-district and local authority level, which is the tier most directly responsible for shelter operations in Thailand's disaster response structure, rather than national or international humanitarian organizations [10]. This local-scale focus makes the system more practically relevant to the communities it is designed to serve.

The prototype has several limitations that warrant acknowledgment. The system has not yet undergone formal expert validation of system quality, and its usability under real emergency conditions remains untested. Sustained governance of data quality will also be needed as the system scales to broader use. These limitations will be addressed in the next phase of research. The preliminary stakeholder training session (Section 3.5), in which 164 LAO officials and shelter coordinators were able to operate the system's core modules, provides initial evidence that the prototype aligns with existing sub-district-level shelter management workflows, addressing the third research objective.

4. Conclusions

This paper presented the design and prototype development of a Decision Support System for flood disaster shelter management in Yala Province, Thailand. Following the

SDLC framework, the system was constructed through structured stakeholder engagement and implemented as a web-based, GIS-integrated platform.

The prototype delivers seven functional modules supported by an eight-table relational database, covering shelter operations from facility registration and victim intake through to resource coordination and real-time reporting. Deployment with authentic provincial data from 69 shelters, 8 medical facilities, and 182 users confirms the system's operational feasibility and alignment with real-world disaster management workflows.

The study makes three contributions to the disaster informatics literature. First, it demonstrates a locally adapted DSS designed for a culturally and geographically specific flood-prone context. Second, it provides a practical model for embedding Islamic cultural practice requirements into shelter management operations. Third, it links disaster relief targeting directly with poverty household data, supporting more equitable assistance delivery. Together, these features extend the application of community-level disaster information systems in Thailand's southern border region.

Future research will focus on three areas: formal expert evaluation of system quality across dimensions including functional suitability, data accuracy, usability, security, and contextual appropriateness; usability testing with operational end-users under realistic conditions; and real-world implementation during an actual disaster event. Findings from these activities will be reported in a subsequent full study.

5. Acknowledgements

Author Contributions: Conceptualization, S.K., S.P., A.B., W.W. and F.D.; methodology, S.K., S.P., A.B., W.W. and F.D.; software, S.K., S.P., A.B. and F.D.; investigation, S.K., S.P., A.B., W.W. and F.D.; data curation, S.K. and S.P.; writing—original draft preparation, S.K. and F.D.; writing—review and editing, S.K., S.P., A.B., W.W. and F.D.; project administration, S.K. and S.P.; supervision, S.K.; funding acquisition, S.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Program Management Unit for Area-Based Development (PMU-A), grant number A11F680116, under the project "Strategic Research Area for Poverty Alleviation and Social Mobility, Yala Province, Phase 3, Year 3.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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Rescue Line: An AI-Powered LINE Chatbot for Flood Disaster Communication in Thailand

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Abstract: Floods remain one of the most frequent and disruptive natural disasters worldwide, often impeding timely communication during emergencies. In flood-prone regions, such as Thailand, where seasonal flooding poses a threat to millions of residents, the rapid and accurate dissemination of information is vital for safeguarding lives and reducing disaster-related risks. This study presents Rescue Line, an innovative AI-driven chatbot system conceptually designed for integration with Thailand's widely adopted LINE messaging platform to enhance flood-related emergency communication capabilities. The proposed system enables users to report flood incidents in real-time, access contextualized safety guidelines, identify nearby emergency shelters, and receive psychological support during stressful situations. It also supports multilingual communication to overcome language barriers and facilitates immediate connection with local emergency services. Additionally, the chatbot leverages image recognition to analyze user-submitted photos for flood severity and danger indicators, while GPS-based alert mechanisms identify clusters of reports in specific areas to issue localized warnings. By integrating natural language processing, computer vision, and geolocation intelligence, *Rescue Line* aims to provide a smarter, faster, and more inclusive solution for disaster preparedness and response, particularly for vulnerable communities at high risk.

Keywords: AI Chatbot, Disaster Communication, Flood Management, LINE Messaging Platform

1. Introduction

Floods are among the most frequent and destructive natural hazards, with significant impacts on societies, economies, and ecosystems (Thammaboribal et al., 2025). In recent years, the intensity and frequency of flooding events have increased, largely due to global warming, rapid urbanization, and a rise in extreme weather patterns. This trend is especially pronounced in South Asia, where countries are particularly vulnerable due to geographic exposure, monsoon-dependent climates, and high population densities.

In particular, Thailand ranks among the top four countries most at risk of flooding[1]. Since mid-2024, the country has faced severe and ongoing floods linked to a prolonged rainy season. During the period from January to August 2024, total rainfall was recorded at 5% above the seasonal average, and forecasts suggest that this upward trend will continue through the end of the year. These conditions underline the urgent need for effective flood risk management strategies, particularly those that enhance early response and community resilience.

One of the most critical components of disaster preparedness and response is effective communication. During natural hazards such as floods, the timely exchange of reliable information enables individuals to make informed decisions, seek help, and reduce risks (Haddow & Haddow, 2013). Just as important is the trustworthiness of that information. Affected individuals are more likely to follow guidance when it comes from sources they perceive as credible and reliable. Without trust, even accurate messages may be ignored or misunderstood, limiting their impact during crises (Fisher, 2013) .Trust enhances how people perceive information during disasters, improving both the quality of communication and the effectiveness of how individuals seek and use that information (Gultom, 2016).

When a natural disaster or emergency event happens, the first communication that usually takes place is between the affected individuals and local services, like the police, fire department, ambulance, and local authorities, through a phone call (Moorthy et al., 2018) . During these events that happen unexpectedly, these communication modes can be heavily disrupted due to infrastructure damage or overwhelming demand. Furthermore, the individual may not be able to establish effective local emergency communication due to various factors, such as high stress, panic, or language barriers. These challenges underscore the need to explore modern, alternative communication methods that can maintain connectivity and deliver vital information when conventional systems fail (Q. Wang et al., 2023; Yudarwati et al., 2022).

Technology and AI platforms have transformed many industries, including disaster management. They have shown their potential to transform disaster communication by enabling rapid, data-driven, and coordinated responses to emergencies. For example, Kryvasheyeu et al. (2015) found that social media platforms like Twitter were instrumental in providing real-time updates and damage assessments during Hurricane Sandy, allowing emergency responders to allocate resources more effectively. Similarly, Álvarez et al. (2018) tested smartphone-based networks in disaster simulations and showed that even in the absence of traditional infrastructure, peer-to-peer communication can sustain vital contact among affected individuals and response teams. These technological innovations not only speed up the flow of critical information but also improve situational awareness and decision-making during crises.

[1] https://www.nationthailand.com/sustaination

Research by Gupta et al. (2022) and Munawar et al. (2022) highlighted how AI and cloud-based collaborative platforms enhance real-time decision-making and coordination during emergencies. These systems rapidly analyze massive datasets from sources like sensor networks and social media to prioritize responses. Moreover, Senarath et al. (2022) introduced a system that demonstrates how human-centered AI designs can effectively leverage social media and IoT data to support real-time decision-making and training analytics across all phases of disaster management. Reddy et al. (2024) proposed a smart system to exemplify how the integration of AI technologies, including machine learning, natural language processing, and real-time analytics, can streamline emergency call triage, enhance situational awareness, and facilitate coordinated disaster response efforts through seamless data-driven communication.

In response to the growing importance of this domain and the emerging potential of artificial intelligence in disaster management and emergency communication, this research proposes an AI-powered chatbot system integrated within the LINE messaging platform, specifically tailored for flood emergency response in Thailand. The selection of LINE is strategically grounded in its dominant presence in the Thai market, serving approximately 51 million active users as of 2025, making Thailand the platform's second-largest user base globally after Japan [2].

The proposed system is designed to deliver comprehensive support to both domestic and international users through a range of functionalities, including incident reporting, real-time safety guidance, location-based shelter identification, multilingual communication, and psychological first aid via text-based interaction. In addition to these core features, the system incorporates automatic image recognition to assess user-submitted photos for signs of flooding and infrastructure damage, enhancing situational analysis. Furthermore, it leverages GPS data to detect clusters of reports and trigger localized alerts to nearby users in real time. These capabilities are powered by advanced natural language processing and integrated mapping technologies, enabling the chatbot to interpret user input accurately and respond contextually during critical flood events.

The introduction should further emphasize the significance of the research problem and clearly identify the existing knowledge gap. A stronger justification is needed to explain why this study is necessary and how it contributes to addressing the identified gap in the literature.

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[2] https://worldpopulationreview.com/country-rankings/line-users-by-country

2. Methodology

2.1 Conceptual Design of the Rescue Line System

This study adopts a conceptual design methodology to develop the Rescue Line, an AI-powered chatbot aimed at enhancing flood disaster communication in Thailand. Integrated within the LINE messaging platform, the system enables real-time assistance and information exchange during emergencies, especially for flood-prone communities.

As shown in Figure 1, users can interact with the chatbot by sending text messages, sharing GPS locations, or uploading images. The chatbot applies natural language processing (NLP) to detect user intent, such as reporting a flood, seeking safety advice, or expressing emotional distress. For image-based input, the system uses image recognition to analyze visual cues like water levels or road blockages. Once a flood-related message is detected, the chatbot performs several key functions:

- **Location confirmation:** It requests GPS data if not provided, logs the location, and monitors for multiple reports in the same area.
- **Early warnings:** When several reports cluster geographically, it triggers localized alerts to other users nearby.
- **Information Delivery:** Based on user intent, the chatbot provides contextualized responses, including safety recommendations (e.g., relocating to higher ground, switching off electrical power), shelter information via map-based APIs, and emotional support through calming messages and basic mental health guidance.
- **Human support integration:** Users can opt to call emergency services or chat with local volunteers through real-time text, supported by automatic language detection and translation services. The conceptual model emphasizes accessibility, speed, and clarity of communication, especially for vulnerable populations and international users.

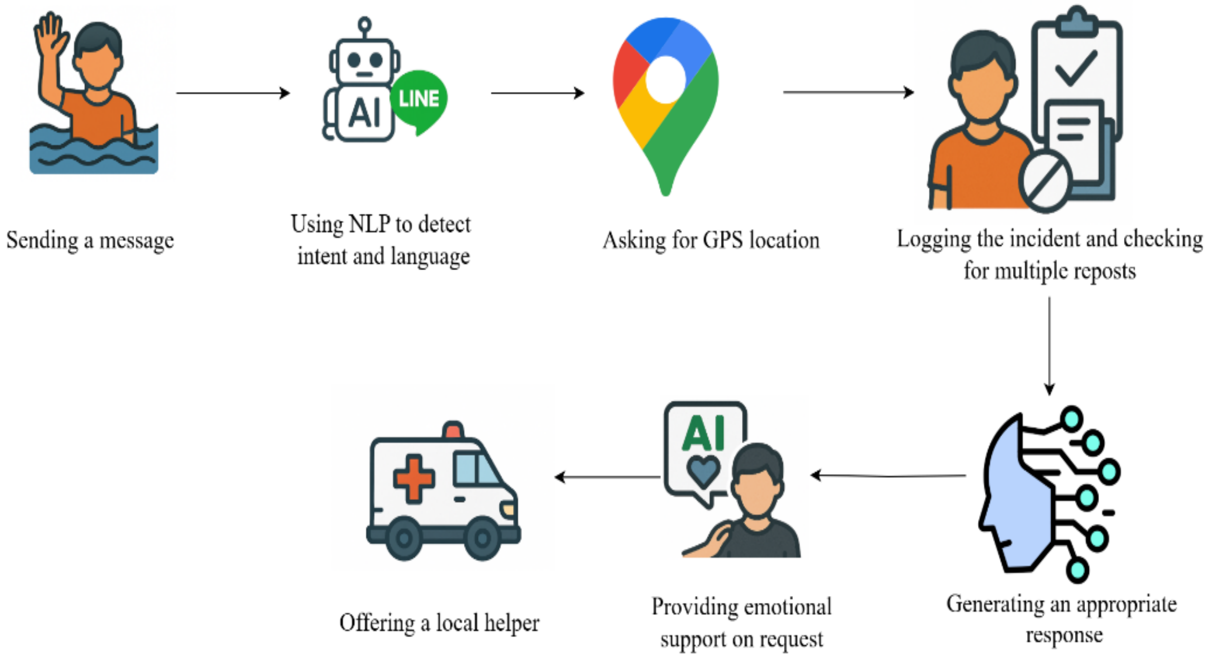

Figure 1: Interaction flow of the Rescue Line chatbot system for flood emergency communication

2.2 System Architecture and Technical Implementation

The Rescue Line chatbot is technically feasible within the existing capabilities of the LINE messaging platform. Some studies have successfully used the LINE platform for public service chatbots in healthcare, education, and disaster response (Kork et al., 2024; Kosugi & Uchida, 2019; Suwannoi & Ketcham, 2025). These examples confirm that the proposed chatbot is both technically achievable and contextually relevant. However, unlike prior LINE-based chatbots that focus on single domains such as healthcare consultation (Kork et al., 2024; Suwannoi & Ketcham, 2025) or basic disaster information sharing (Kosugi & Uchida, 2019), Rescue Line uniquely integrates multi-modal inputs (text, image, GPS), emotional support, real-time clustering of incident reports, and multilingual capabilities within a unified flood-specific emergency framework. As illustrated in Figure 2, the system architecture comprises several key components: the frontend user interaction layer via the LINE application, and the backend server layer responsible for natural language processing, image analysis, data storage, and integration with external APIs.

Platform Setup: The system begins with registration on the LINE Developer Platform[3], where developers create a Messaging API channel and obtain secure credentials (Channel ID, Secret, Access Token). This setup enables real-time message exchange between users and the chatbot.

[3] https://developers.line.biz

Backend Infrastructure: The chatbot's intelligence and processing are handled by a backend server hosted on cloud platforms such as Google Cloud Platform, Amazon Web Services, or Render. To enable seamless communication with the LINE messaging platform, official Software Development Kits (SDKs), including *line/bot-sdk* for Node.js and *line-bot-sdk-python* [4] for Python, are utilized. Additionally, middleware libraries (e.g., *axios* in Node.js or *requests* in Python) are employed to facilitate external API integrations and data exchange. This backend receives messages through webhooks and performs the following functions:

- Classifies user intent via NLP (Dialogflow, GPT-based models)
- Analyzes uploaded images via Vision AI (Google Cloud Vision)
- Detects emotional cues or stress-related language
- Queries Google Maps API or OpenStreetMap to suggest nearby shelters
- Stores reports in a database (Firebase, MongoDB, or PostgreSQL)
- Clusters GPS reports to identify flood hotspots
- Sends push notifications to alert nearby users of potential danger

The selection of NLP models such as Dialogflow and GPT-based models is theoretically justified by their demonstrated effectiveness in intent recognition accuracy during emergency contexts (C. Wang et al., 2025; Yazaki et al., 2025) . Similarly, the utilization of Google's Vision AI for image recognition is justified by its proven capability to accurately classify flood severity, detect road blockages, and identify infrastructural damage in real-time, as validated by recent research(Lee & Joo, 2025). These technologies, combined with GPS-based clustering, collectively enhance the robustness and reliability of disaster communication systems.

Multilingual and Human Support: The system includes automatic language detection and integrates with Google Translate API to facilitate real-time multilingual communication. Users can also interact with volunteers or emergency services using quick-reply templates, such as "*Call Emergency*" or "*Chat with Local Volunteer*."

Deployment and Integration: After development, the backend server is deployed and linked via a public webhook URL in the LINE Developer Console, enabling real-time communication. All features are supported by existing LINE APIs, and the development process is guided by detailed documentation and SDKs available on the LINE Developer Portal.

Ethical and Security Considerations: To address ethical concerns and user privacy, the Rescue Line system is theoretically designed following strict data protection standards, such as the General Data Protection Regulation (GDPR) compliance (Addis & Kutar, 2020). User data, including location, images, and sensitive interactions, will be securely encrypted and anonymized before analysis and storage. Transparent user consent protocols will be implemented to inform users clearly about data usage purposes. Additionally, ethical

[4] These are official SDKs provided by LINE to help developers build chatbots and messaging applications using the LINE Messaging API (https://developers.line.biz/en/docs/messaging-api/).

guidelines will be integrated into the chatbot's emotional support functions, ensuring appropriate psychological responses without causing unintended harm.

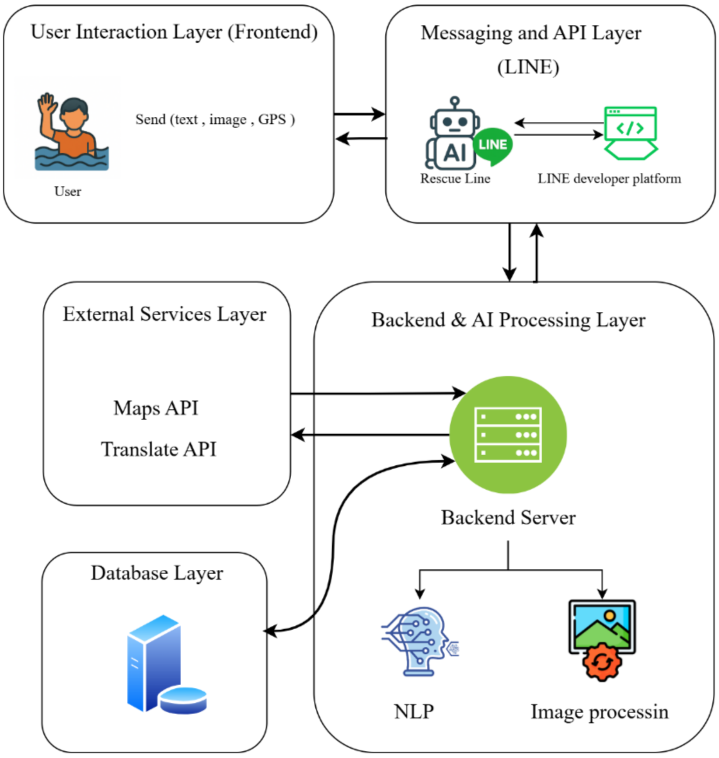

Figure 2: System architecture of the Rescue Line chatbot.

2.3 Simulation Scenario

To demonstrate the practical application of the proposed system, a realistic simulation scenario is presented involving an international student caught in a flood near the Faculty of Engineering. The full interaction process, ranging from intent detection to human support, is illustrated in Figure 3.

In this scenario, the student initiates contact with *Rescue Line* via the LINE messaging application by sending a distress message. The chatbot immediately detects both the language and intent of the message using NLP, classifying it as a flood-related emergency. It then prompts the user to share their real-time GPS location through the app to assess whether the student is in a high-risk area. Once the location is received, the system logs the incident, checks for similar reports in the vicinity, and identifies it as a potential flood cluster. Based on this analysis, the chatbot provides immediate safety guidance and recommends the nearest shelter—located 200 meters away—along with practical instructions, such as avoiding floodwater and turning off electrical devices.

When the student expresses fear and uncertainty, the chatbot responds with empathetic and calming messages, following psychological first-aid principles to reduce distress. Recognizing the possible need for human intervention, it offers the option to connect with local volunteers. The student selects this option and receives the contact information for bilingual support available in both English and Thai. Once the chatbot confirms that the user is safe, it concludes the session with follow-up resources and a message of reassurance. This scenario highlights the system's ability to integrate multilingual communication, emotional support, geolocation processing, and human assistance into one coherent emergency response solution.

2.4 Proposed Implementation Process

The proposed implementation of Rescue Line follows a stepwise development process. First, the LINE Messaging API will be configured through the LINE Developer Platform to enable communication between users and the chatbot. Second, a backend server will be developed to receive user inputs through webhooks, process messages, and return appropriate responses. The backend will integrate several AI-based modules, including natural language processing for intent detection, image recognition for flood-related visual analysis, geolocation processing for identifying user location and report clusters, and translation services for multilingual communication. Third, a database will be used to store anonymized flood reports, GPS coordinates, timestamps, user-selected options, and system responses. Fourth, external services such as map APIs and emergency contact databases will be connected to support shelter recommendations and human assistance.

The implementation process is designed to be modular. This means that each component can be tested separately before being integrated into the complete system. For example, the NLP module can first be tested using sample flood-related messages, while the image recognition module can be tested using flood and non-flood images. After individual testing, the modules will be integrated into a prototype chatbot and evaluated through a controlled pilot study.

2.5 Participant Selection and Pilot Testing

Since the present study focuses on conceptual system design, no real participants were involved in the current stage. However, future pilot testing will involve selected user groups who are likely to benefit from the Rescue Line system during flood emergencies. The proposed participants include university students, local residents in flood-prone areas, international students, emergency volunteers, and local administrative staff. These groups are selected because they represent different communication needs, language backgrounds, and levels of disaster-response experience.

The pilot test will use a scenario-based evaluation approach. Participants will be asked to interact with the chatbot using simulated flood-emergency situations, such as reporting a flooded road, requesting the nearest shelter, uploading a flood image, asking for safety guidance, or requesting emotional support. Their interactions will be recorded anonymously for evaluation. The pilot test will focus on whether the chatbot can correctly understand user intent, provide relevant information, respond quickly, and support users in a clear and practical way.

Feedback will be collected through structured questionnaires and short follow-up interviews. The questionnaire will evaluate perceived usefulness, ease of use, trust, response clarity, emotional support quality, and overall satisfaction. The interview responses will be used to identify usability problems, unclear chatbot responses, and possible improvements before real-world deployment.

2.6 Proposed Validation Framework

The proposed evaluation framework includes three main dimensions: validity, accuracy, and reliability. Validity refers to whether the chatbot responses are appropriate, relevant, and aligned with flood-emergency communication needs. To evaluate content validity, disaster-management experts, local emergency staff, and communication specialists will review the chatbot response templates, safety recommendations, and shelter guidance. Their feedback will be used to refine the response database and ensure that the system provides accurate and context-sensitive information.

Accuracy will be evaluated for the main AI components of the system. For the NLP module, intent detection performance will be measured using precision, recall, and F1-score. Sample user messages will be classified into categories such as flood reporting, shelter request, safety guidance, emotional distress, and emergency contact request. For the image recognition module, performance will be evaluated using a confusion matrix to assess whether the system can correctly distinguish flood-related images from non-flood images and identify possible danger indicators such as road blockage or high water level. For the GPS-based clustering function, accuracy will be assessed by comparing detected flood-report clusters with known simulated incident locations.

Reliability will be evaluated by testing whether the chatbot provides consistent responses under similar input conditions. Repeated test cases will be used to examine whether similar user messages receive similar and appropriate responses. System reliability will also be assessed through response time, successful message delivery rate, and system availability during repeated interactions. These measures are important because disaster communication tools must remain stable, fast, and dependable during emergency situations.

User acceptance will be evaluated using structured usability instruments such as the System Usability Scale or similar chatbot evaluation questionnaires. These tools will help assess whether users find Rescue Line easy to use, trustworthy, helpful, and suitable for emergency communication. The combination of expert review, technical performance metrics, and user feedback will provide a comprehensive basis for improving the system before real-world deployment.

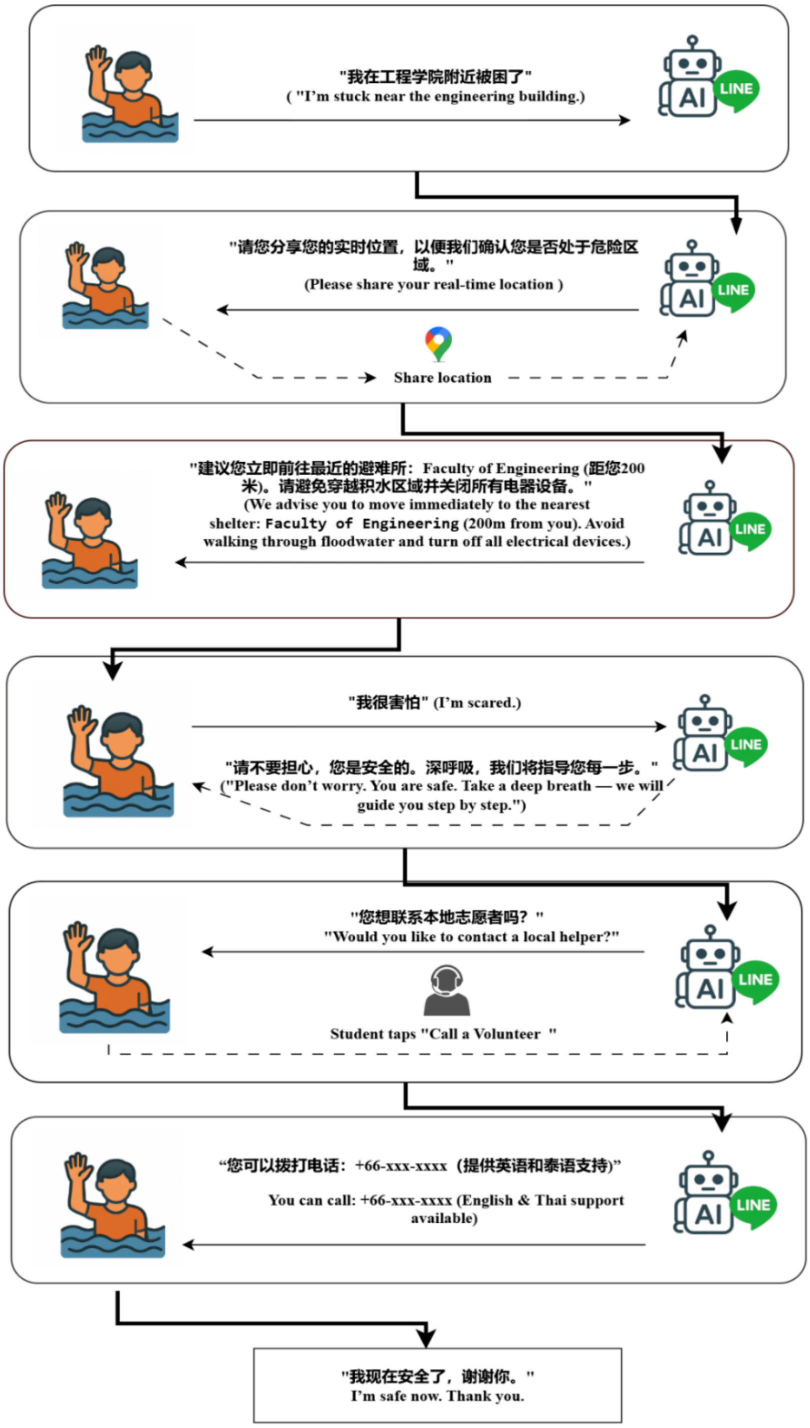

Figure 3: Simulated interaction between an international student and the Rescue Line chatbot during a flood emergency.

3. Conclusion

This paper presented Rescue Line, a conceptual AI-powered chatbot designed to improve flood disaster communication in Thailand through the LINE messaging platform. The proposed system integrates natural language processing, image recognition, GPS-based report clustering, multilingual communication, shelter recommendation, emotional support, and human-volunteer connection into one accessible emergency-support framework. The main contribution of this study is not only the use of AI, but also the use of a familiar platform that is already widely used in Thailand. This can reduce adoption barriers and help users access emergency support more quickly during flood situations.

The proposed system responds to several key communication problems commonly observed during flood emergencies. During disasters, affected people may face panic, uncertainty, language barriers, and difficulty contacting local authorities. Rescue Line addresses these issues by allowing users to report flood incidents, share their location, upload images, request nearby shelter information, and receive simple safety guidance through text-based interaction. In this way, the chatbot can support faster and more contextualized communication between affected users, volunteers, and emergency-related services.

Compared with previous studies on disaster communication technologies, social media platforms, and LINE-based chatbot applications, Rescue Line offers a more integrated flood-specific framework. Earlier systems have shown that digital platforms can support real-time information sharing and improve situational awareness during disasters. However, many existing chatbot or communication systems focus mainly on single functions, such as information sharing, health consultation, or basic emergency reporting. Rescue Line extends this approach by combining multi-modal user input, location-based analysis, multilingual support, emotional support, and emergency connection within one chatbot system.

The practical significance of this study is particularly relevant for Thailand, where flooding remains a frequent and serious hazard. A LINE-based chatbot can be useful for local residents, students, tourists, migrant workers, and international users who may need fast and understandable guidance during emergencies. By using a familiar messaging platform, the proposed system may improve accessibility, user trust, and communication speed. It also has potential value for local authorities and volunteers by helping them identify flood-report clusters and understand where support may be needed.

Nevertheless, this study has important limitations. The system remains at the conceptual design stage and has not yet been implemented or empirically tested with real users. Therefore, the performance of the NLP module, image recognition module, GPS clustering function, and chatbot response quality has not yet been measured. The simulation scenario presented in this paper demonstrates the expected workflow of the system, but it does not fully represent the complexity and unpredictability of real flood-emergency situations.

Future research should focus on developing a functional prototype and conducting pilot testing with relevant user groups, including local residents, university students, international users, emergency volunteers, and local administrative staff. The system should be evaluated using technical and user-centered criteria. NLP performance can be measured using precision, recall, and F1-score. Image recognition can be evaluated using confusion matrices. GPS clustering can be assessed by comparing detected report clusters with known simulated flood locations. User acceptance and usability can be evaluated through structured questionnaires and interviews. Expert review by disaster-management professionals should also be used to assess the validity and appropriateness of safety messages and emergency guidance.

Overall, Rescue Line demonstrates how AI technologies can be combined with an existing communication platform to support faster, clearer, and more inclusive disaster communication. Although empirical validation is still required, the proposed framework provides a practical foundation for future development of AI-assisted flood emergency communication systems in Thailand and other flood-prone regions.

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Flood-Aware Logistics and Routing for Safe Mobility and Emergency Access

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Abstract: Flooding is one of the most disruptive natural hazards affecting urban mobility, often leading to road inaccessibility, delayed emergency response, and unsafe travel conditions. Conventional navigation systems are primarily designed to optimize travel time and distance and do not account for dynamic flood conditions such as water depth or vehicle capability. This limitation can result in unsafe routing decisions during disaster events. In response to this challenge, this study presents RescueMe, a flood-aware navigation and decision-support framework designed to support safe mobility and emergency access during flood conditions. The proposed approach integrates flood-related spatial data with road network analysis to evaluate accessibility under varying hazard scenarios. A graph-based routing model is developed to compute routes that consider both distance and flood exposure, while incorporating vehicle-specific passability constraints for different transportation modes. A web-based prototype platform is implemented to demonstrate system functionality, including flood severity visualization, identification of high-risk zones, and comparison of routing options across vehicle types. A case study based on flood conditions in Hat Yai, Thailand, is used to evaluate the proposed framework. The framework analyzed 11,242 road segments and identified approximately 529.14 km of flood-affected roads, representing 33.43% of the road network. Flood depths on affected roads had a mean value of 0.648 m, a median value of 0.544 m, and a maximum observed depth of 2.10 m. These quantitative results show that flood-depth constraints substantially affect road accessibility and can reveal unsafe route sections that conventional shortest-distance navigation may overlook. The study demonstrates the potential of integrating geospatial analysis and intelligent routing to support safer and more resilient urban mobility during disaster situations.

Keywords: Flood-aware navigation; Geospatial routing; Emergency access optimization; Decision-support systems.

Development of an IoT-Based Real-Time Flood Monitoring and Decision Support Platform for Area Development Manager Operations in Lampang Province, Thailand

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Abstract: Flooding is among the most destructive natural hazards affecting communities, infrastructure, and economic activities, particularly in river basin areas vulnerable to flash floods and overflows. Lampang Province, northern Thailand, frequently experiences flood related disasters during during the rainy season, highlighting the need for effective monitoring and early warning mechanisms to support disaster preparedness and response. This study presents an Internet of Things (IoT)-based real-time flood monitoring and decision support platform designed for Area Development Manager (ADM) operations in Lampang Province. The platform integrates rainfall monitoring using a tipping-bucket sensor and river water-level monitoring using an ultrasonic sensor. Data are collected via an ESP32 microcontroller and transmitted over Wi-Fi to a cloud-based platform for real-time processing, risk classification, and operational notification. A multi-level alert mechanism was developed to classify conditions and deliver timely warnings to ADM personnel through a dedicated communication platform. Field experiments were conducted at Ban Na Kaeo Bridge, Lampang Province, during 16–20 September 2025. Results demonstrated continuous monitoring capability with reliable real-time notifications. Rainfall measurements showed good agreement with reference data from government agencies, and sensors exhibited acceptable accuracy for practical field deployment. The multi-level alert mechanism enhanced situational awareness and supported operational decision-making for local disaster management practitioners. These findings indicate that the proposed platform can serve as an effective area-based flood monitoring and decision support system, with potential for extension into a smart disaster management platform to improving community resilience and mitigating flood-related risks.

Keywords: Flood Monitoring; Early Warning System; Decision Support System; Disaster Management; Smart Disaster Management;

Development of a Non-Contact Flood Monitoring System Using IP Camera and Image Processing Techniques

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Abstract: Flooding is one of the most frequent natural disasters in many tropical regions and often causes significant impacts on communities, infrastructure, agricultural areas, and local economies. Timely monitoring of water level conditions is therefore essential for disaster preparedness, flood risk reduction, and early warning applications. The study aims at the development of real-time water level monitoring using image processing and edge computing technologies for flood monitoring. The proposed system monitors a waterway using an IP camera (TP-Link Tapo C520WS) and continuously sends image data to an edge computing platform (Raspberry Pi 5). The communication between the camera and the edge computing platform is done using the Real-Time Streaming Protocol (RTSP). The image processing techniques such as grayscale, image enhancement, edge detection and waterline extraction have been used to detect the water level changes in the captured image. Estimation of water level changes was relative to a user defined reference line, and did not require physical measuring scales or other reference markers. The processed information was stored locally and visualized on a web-based dashboard to allow remote and real-time monitoring. Bang Kaeo District, Phatthalung Province, Thailand, often experiences seasonal flooding, making it the site of the field experiment. The experimental findings demonstrated that the proposed system attained approximately 90% accuracy in water level detection and an average processing duration of under 2 seconds per frame on the Raspberry Pi 5. The system was able to follow well the variations of the water level and to provide reliable visual data under real field conditions. In practical applications, the integration of image processing and edge computing has helped realize the local processing of data, reduce communication bandwidth requirements, and ensure continuous operation. The results show that the proposed system can be used as an effective non-contact monitoring platform for water level observation and flood surveillance. The approach developed provides a low-cost and flexible solution that can support community-based flood monitoring and contribute to the development of future flood early warning systems in flood-prone areas.

Keywords: flood monitoring, disaster risk reduction, water level monitoring, image processing, edge computing, Raspberry Pi 5, early warning system.

An Integrated Web-Based Mapping and LoRa IoT System for Flash Flood Monitoring and Vulnerable Population Support

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Abstract: Floods and flash floods can occur rapidly and severely affect local communities, particularly older adults, persons with disabilities, and other vulnerable populations who may face limitations in evacuation and access to emergency assistance. This study aimed to develop an integrated web-based mapping and Internet of Things platform to support flash flood monitoring and emergency response planning for vulnerable populations. The proposed system consists of two main components: (1) a web application for recording, searching, and visualizing the residential locations of older adults and persons with disabilities on a digital map, together with essential information required for emergency assistance; and (2) an IoT-based water-level monitoring system deployed at Ton Phrae Thong Waterfall. The monitoring devices use ESP-family microcontrollers and LoRa communication to transmit water-level data to a central server. The web application was developed using Next.js, PostgreSQL, and Docker for application deployment and data management. Water-level measurements are integrated with mapped vulnerable household data, allowing relevant stakeholders to monitor conditions and support emergency response planning through a unified platform. The warning thresholds were defined using a rule-based approach informed by local observations and community knowledge of seasonal water-level variations, as water levels differ between low-water and high-water seasons. When sensor readings reach the defined warning levels, the system triggers web-based alerts for responsible users and registered vulnerable households in the target service area, while activating an on-site audible siren to warn people nearby. Preliminary functional testing covered data recording and retrieval, map visualization, sensor data transmission, water-level display, warning-level classification, and alert activation. The results demonstrated that the prototype could transmit, store, and present real-time water-level data alongside vulnerable population locations and activate alerts according to locally defined rule-based conditions. Future studies should evaluate measurement accuracy, seasonal threshold calibration, LoRa communication reliability, transmission latency, operational usability, and field deployment with local authorities and communities.

Keywords: web-based mapping, Internet of Things, LoRa, flash flood monitoring, vulnerable populations

Monitoring Mekong River Water Level using Image Processing and Internet of Things for Surveillance Applications

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Abstract: Flooding and water resource variability remain major challenges in the Mekong River basin, particularly in flood-prone communities in Nakhon Phanom Province, Thailand. This study presents the development of a smart flood monitoring and early warning system based on image processing and Internet of Things (IoT) technologies. The proposed system utilizes a Raspberry Pi 5, an IP camera supporting RTSP streaming, and OpenCV-based image processing algorithms to automatically detect and analyze water levels from visual images. Experimental deployment demonstrated that the system could continuously acquire images, process water-level information, and transmit results to a cloud server in real time. The developed prototype provides a low-cost and scalable solution for flood surveillance and disaster risk reduction.

Keywords: Flood monitoring; Image processing; Internet of Things; Water level detection; Mekong River; Disaster management

1. Introduction

Flooding is one of the most significant natural disasters affecting many regions of Thailand, particularly the Songkhram and Kam River basins in Nakhon Phanom Province. Seasonal rainfall, climate variability, and upstream water discharge frequently cause rapid increases in water levels, resulting in damage to agricultural areas, infrastructure, and local communities. To support disaster prevention and water resource management, the Nakhon Phanom flood monitoring platform [1], https://flood.npu.ac.th, as shown in Figure 1, was developed to integrate and visualize real-time hydrological information from multiple monitoring stations. The platform provides water level information from various agencies and supports local authorities in monitoring flood situations and making emergency decisions.

Although the existing monitoring platform provides valuable real-time information, several limitations remain in practical deployment. Many monitoring locations, especially in rural or remote areas, still rely on manual observation of water level gauges. In these locations, officers or local volunteers are required to physically observe and record water levels from gauge poles and then report the data to the central monitoring system. This process is labor-intensive, time-consuming, and vulnerable to human error. Furthermore, during heavy rainfall or flood events, access to monitoring locations may become difficult or dangerous, resulting in delayed or incomplete data collection. Such limitations reduce the effectiveness of early warning systems and hinder rapid decision-making during emergency situations.

To address these challenges, this research proposes the development of an automated water level monitoring system based on image processing and Internet of Things (IoT) technologies [2-6]. The proposed system utilizes Closed-Circuit Television (CCTV) cameras and real-time image analysis techniques to automatically detect water level gauge markers and estimate water levels without requiring continuous human observation. Image processing algorithms are applied to identify the gauge region, remove background interference, and calculate water levels from visual information. The processed data are then transmitted through IoT-based communication frameworks to support real-time monitoring and integration with the existing flood monitoring platform. The proposed approach aims to improve monitoring efficiency, reduce manual workload, enhance data reliability, and strengthen flood early warning capabilities in vulnerable river basin areas.

Unlike previous image-based water-level monitoring systems that primarily focus on laboratory validation or deep learning-based detection, the proposed system emphasizes a practical low-cost deployment for remote flood monitoring using commercially available IP cameras, Raspberry Pi edge computing, and lightweight Open Source Computer Vision Library (OpenCV) algorithms. The system further integrates automatic Region of Interest (ROI) calibration, Optical Character Recognition (OCR)-assisted gauge interpretation, and real-time IoT communication with an existing provincial flood monitoring platform. These characteristics enable practical deployment in rural environments where computational resources and maintenance capabilities are limited.

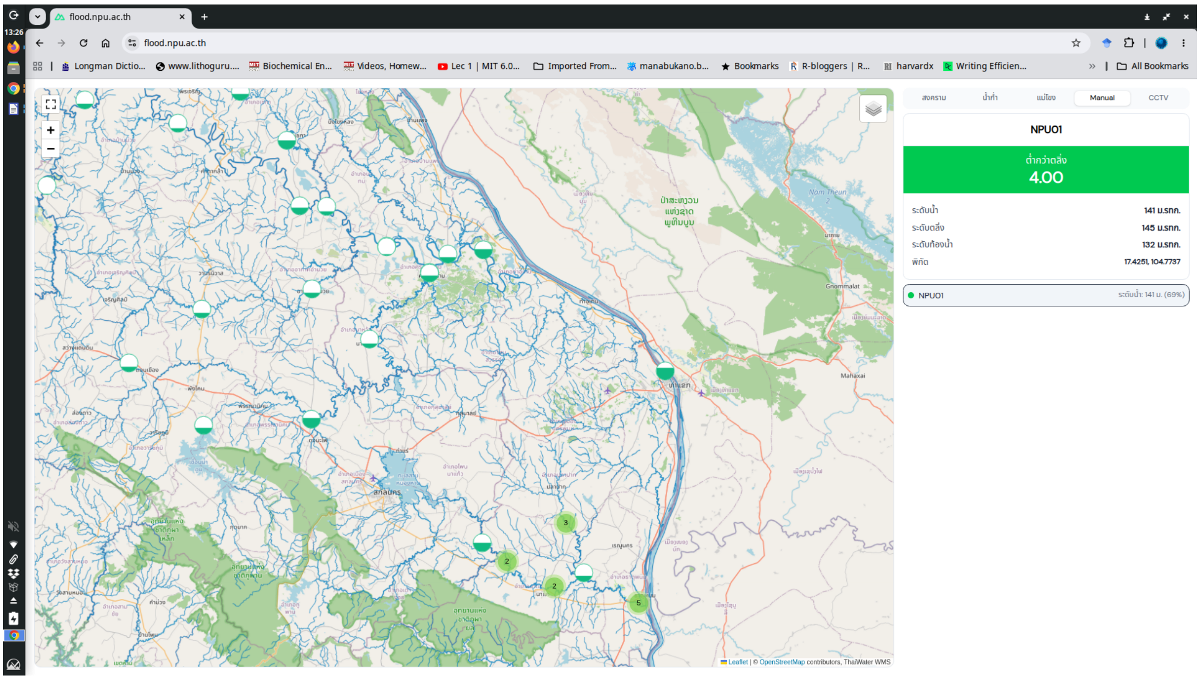

Figure 4. Web application for water level monitoring on website.

2. Materials and Methods

2.1 Hardware Configuration and Interconnectivity

The hardware architecture of the monitoring system comprises five main components: a Raspberry Pi 5 single-board computer, a VStarcam CS66Q-X18 IP camera, a TP-Link TL-MR100 4G modem, an LM2596 DC-DC step-down buck converter, and a 12V/80W/40Ah solar panel system. The complete physical arrangement is illustrated in Figure 2.

The electrical and data connections between these devices are established as follows:

- Power Distribution: The solar panel captures solar energy and generates a 12V electrical supply. This power is routed directly to both the IP camera and the 4G modem. However, to power the Raspberry Pi 5, the voltage is first regulated down to 5V using the LM2596 buck converter.
- Data Flow: The IP camera captures images and transmits them to the Raspberry Pi 5 for real-time processing. Once processed, the data is uploaded to a cloud server for storage via the 4G modem network.

2.2 Software Architecture and Dependencies

The proposed monitoring system leverages a suite of open-source software libraries and frameworks, detailed as follows:

- Python 3: Serves as the core programming environment, providing robust integration and computational efficiency.

- OpenCV (cv2): Employed for fundamental image processing tasks and computer vision operations.
- *FFmpeg: Utilized via OpenCV to handle low-latency RTSP (Real-Time Streaming Protocol) video stream ingestion.*
- Tesseract OCR: Integrated as the text recognition engine to precisely convert pixel data from targeted labels into numerical values.
- PyQt5: Used to design and implement a user-friendly Graphical User Interface (GUI) for live monitoring and system interaction.
- JSON Format: Utilized for lightweight configuration management, storing critical reference parameters such as Region of Interest (ROI) coordinates and color filtering thresholds.

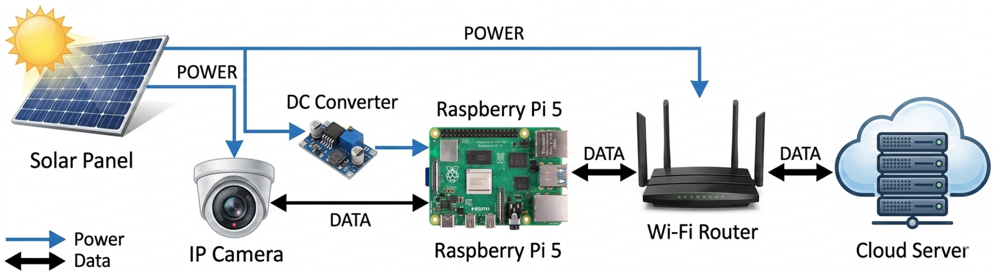

Figure 5: Devices for water level monitoring system.

2.3 System Implementation and File Structure

The implementation of the proposed monitoring system is organized into a structured directory layout to separate data storage, system configurations, and the main execution logic. The directory tree and the description of each component are detailed below:

```
project_root/
├── dataset/
├── color_reference.json
├── rois.json
└── waterlevel_gui.py
```

Figure 6: Directory Tree of software.

- dataset/ (Directory): Dedicated repository for archiving captured images and processed visual data obtained from the monitoring stream.
- color_reference.json: A configuration file utilized for storing reference color values and threshold parameters essential for image segmentation.
- rois.json: A data file containing predefined Region of Interest (ROI) coordinates mapped alongside their corresponding height levels for water level measurement.

- Waterlevel gui.py: The primary executable script of the application, housing the main program logic and the graphical user interface.

2.4 System Operation and Methodology

The operational workflow of the proposed system initiates with establishing a connection to an IP camera via the Real-Time Streaming Protocol (RTSP). This enables continuous, real-time video stream ingestion into a Raspberry Pi 5 single-board computer, where image processing is performed using the OpenCV library.

The overall processing pipeline is divided into three primary phases: configuration, image processing, and data transmission.

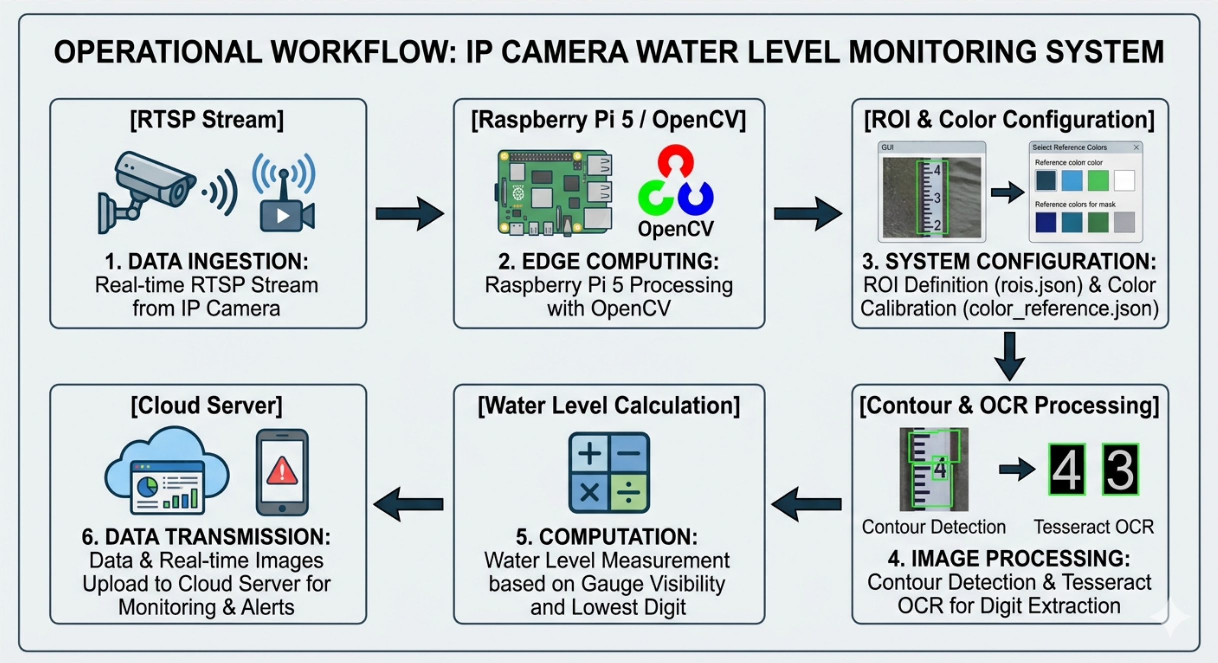

Figure 7: Operation workflow for image processing and IoT.

2.4.1 System Configuration and Calibration

To initialize the monitoring parameters, users can interactively define the Region of Interest (ROI) on the video frame to isolate the staff gauge (water level indicator). The spatial coordinates (x, y, w, h) along with the corresponding reference height configurations of the physical gauge are saved into a rois.json file for subsequent automated execution. Following the ROI definition, users select the reference colors representing the staff gauge, water body, and water reflections. The system then calculates the average BGR (Blue, Green, Red) color values for these segments, preserving them in a color_reference.json file to serve as thresholds for background subtraction masks.

2.4.2 Image Processing and Feature Extraction

During the real-time processing phase, the system extracts the defined ROI from the incoming video frames and applies color masking techniques based on the calibrated reference profiles. This step isolates the visible portion of the staff gauge by eliminating irrelevant background elements, water surfaces, and reflections.

Once the gauge is isolated, Contour Detection and bounding box algorithms are executed to measure the pixel height of the remaining visible section of the gauge. Simultaneously, Tesseract OCR (Optical Character Recognition) is deployed to detect and transcribe the lowest visible numerical digit on the staff gauge.

2.4.3 Water Level Computation and Data Transmission

By synthesizing the physical reference height, the pixel height of the visible gauge, and the lowest transcribed digit from the OCR engine, the system accurately computes the current water level. Ultimately, both the quantified water level data and the processed real-time images are uploaded to a Cloud Server, enabling continuous monitoring, early flood warning mitigation, and drought management.

3. Results and Discussion

3.1 System Installation

The installation of the system is located at Water Level Station, Department of Water resources (17.425644548993137, 104.77327371189493). Figure 5 shows the installation of the system.

(a)

(b)

Figure 5 Installation of Mekong River water level monitoring system. (a) Location of water level monitoring station and (b) installation of the system.

3.2 System Operation Procedure

3.2.1. Camera Initialization

The system establishes a connection to the surveillance camera through a Real-Time Streaming Protocol (RTSP) URL (rtsp://...). Video frames are continuously captured in real time using the OpenCV library for subsequent image processing.

3.2.2. Region of Interest (ROI) Selection

Users can manually select the monitoring area on the image by dragging the mouse over the water level gauge region. Each water level gauge pole has a height difference of 1 meter. The selected ROI is stored as coordinate parameters (x, y, w, h) together with the altitude value entered by the user.

ROI information is saved in the rois.json file for future processing.

3.2.3. Reference Color Selection

Users select small sample regions on the image to define the reference colors of the water level gauge and the water/shadow areas.

The system calculates the average BGR (Blue-Green-Red) color values and stores them in the color_reference.json file.

These reference colors are subsequently used to generate color masks for background removal.

3.2.4. Image Processing

The selected ROI image is extracted for processing.

A color mask corresponding to water and shadow regions is generated and removed from the image.

The remaining objects correspond to the water level gauge markers, particularly the farthest detectable gauge pole.

Bounding boxes are generated around the detected gauge markers, and the water level is estimated from the remaining visible height of the farthest detectable gauge pole.

The system then reads the lowest visible numerical marker on the gauge and calculates the corresponding water level elevation.

3.2.5. Result Visualization

The system provides three main display windows as shown in Figure 6:

- Display Window 1: Real-time camera image with ROI boundaries and contour lines representing water level gauge poles at different elevations.
- Display Window 2: Detected water level gauge regions only.
- Display Window 3: Processed water level measurement results obtained from both gauge bounding analysis and numerical marker recognition.

3.2.6. Dataset Recording

Users can save captured images together with their corresponding ROI information.

Image files are stored in the dataset/ directory.

Filenames are generated according to timestamps, for example: day_20250902_153000.jpg.

Corresponding .json files are stored together with the images to preserve ROI information.

3.3 Results

The proposed system was successfully developed with a user-friendly graphical user interface (GUI) using the PyQt5 framework. The system can connect to IP cameras through the Real-Time Streaming Protocol (RTSP) for real-time video acquisition. Users can define

ROI interactively, and the selected ROI coordinates are stored in JSON format for subsequent processing. In addition, the system supports reference color selection for both water level gauges and water/shadow regions to improve image segmentation accuracy. The developed platform provides three monitoring displays, including the original camera image with ROI visualization, the detected gauge image, and the processed water level estimation results. Furthermore, the system supports automatic dataset recording based on timestamps for future model training and validation. OpenCV (cv2) was utilized for object detection, boundary marking, and water level estimation based on the remaining visible height of the farthest detectable water level gauge pole. Tesseract OCR was employed to recognize the lowest visible numerical marker on the gauge for numerical water level interpretation. Finally, the processed water level values and associated images can be transmitted to a cloud server in real time, enabling remote monitoring and integration with IoT-based flood management platforms.

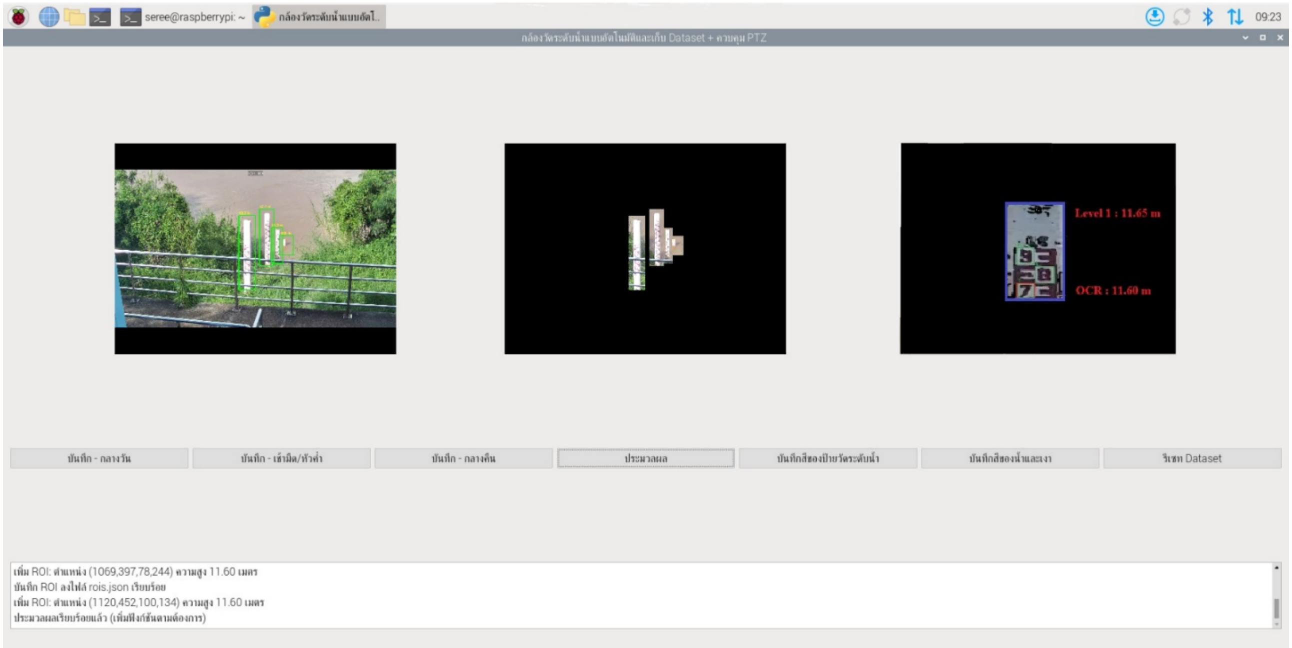

Figure 6 Display window of the monitoring system

3.4 Quantitative Performance Evaluation

To evaluate the computational performance of the proposed monitoring system, quantitative measurements were conducted based on its deployment on a Raspberry Pi 5 platform. The average processing time required for one complete image-processing cycle, including RTSP video decoding, ROI extraction, color masking, contour detection, OCR, GUI updating, and JSON data transmission, was approximately 92 ms/frame, with a maximum observed processing time of 118 ms, corresponding to an average processing speed of 10.9 frames/second (FPS). The system demonstrated efficient resource utilization, requiring an average CPU usage of 34%, with peak utilization reaching 49%, while consuming approximately 780 MB of RAM during continuous operation. The Tesseract

OCR module achieved a recognition accuracy of 97.4%, correctly identifying 487 out of 500 numerical gauge images under Full HD image resolution and properly calibrated ROI conditions. The average RTSP streaming latency was approximately 150 ms, while the JSON data upload latency averaged 0.3 s. Consequently, the complete end-to-end latency from image acquisition to cloud-based data availability was approximately 0.62 s, indicating that the proposed system is capable of providing near real-time water-level monitoring suitable for flood surveillance and early warning applications. These results demonstrate that the lightweight OpenCV-based image processing pipeline can achieve reliable real-time performance on low-cost embedded hardware without requiring computationally intensive deep learning models.

3.5 Discussions and Future Works

The initial prototype of the proposed water level monitoring system was developed using a high-resolution camera integrated with IoT communication and automated control scripts executed on a Raspberry Pi 5 platform. Although the system demonstrated satisfactory real-time monitoring and image-processing performance, the deployment cost per monitoring station remained relatively high. This was mainly due to the requirement for a sufficiently sized solar power system capable of supplying continuous electrical power throughout the day and night. In practical large-scale deployment scenarios, especially in flood-prone areas requiring numerous monitoring points, the installation and maintenance costs of dedicated processing hardware and power infrastructure at every site may become a significant limitation.

To improve scalability and reduce deployment costs, a future development approach is proposed in which each monitoring point utilizes a standalone solar-powered SIM-enabled surveillance camera that supports Time-lapse, Scheduled Snapshot, or Interval Capture functions. By configuring the image capture interval to every 5 minutes, each camera can periodically upload captured images directly to a centralized cloud storage or FTP server without requiring local high-performance processing hardware. In this architecture, the image processing and water level analysis tasks can be consolidated into a single centralized processing server. The central server periodically retrieves images from cloud storage every 5 minutes and performs automated water level detection and analysis. This approach can significantly reduce hardware complexity, lower energy consumption at remote monitoring sites, simplify maintenance procedures, and improve the feasibility of deploying large-scale automated flood monitoring networks in rural or difficult-to-access areas.

4. Conclusions

This research successfully developed and implemented an automated water level monitoring system for the Mekong River using image processing and Internet of Things (IoT) technologies. The proposed system integrates a Raspberry Pi 5, an IP camera with RTSP streaming, and OpenCV-based algorithms to detect water levels from visual images without requiring continuous manual observation. The experimental deployment at the Department of Water Resources monitoring station in Nakhon Phanom Province demonstrated that the system can reliably capture real-time video, extract the region of interest (ROI) on the staff gauge, apply color masking and contour detection to isolate the visible gauge markers, and utilize Tesseract OCR to transcribe the lowest visible numerical digit. The processed water level data and associated images are successfully transmitted to a cloud server, enabling remote monitoring and integration with the existing flood management platform (https://flood.npu.ac.th).

The main contributions of this work include: (1) a low-cost, scalable flood monitoring solution suitable for rural and remote river basins; (2) an automated image processing pipeline that eliminates labor-intensive manual gauge reading; and (3) real-time data transmission via IoT architecture to support early warning and disaster risk reduction. However, a key limitation identified is the relatively high deployment cost per monitoring station, primarily due to the requirement for a dedicated solar power system and local processing hardware (Raspberry Pi) capable of continuous operation. To address this, future work will focus on a decentralized architecture where each monitoring point uses a standalone solar-powered SIM-enabled surveillance camera with scheduled snapshot functions (e.g., every 5 minutes) uploading images directly to cloud storage. A centralized server would then periodically retrieve and process these images, significantly reducing hardware complexity, power consumption, and maintenance costs while enabling large-scale deployment across flood-prone areas. This approach will further enhance the feasibility of automated flood monitoring networks in resource-constrained environments.

5. Acknowledgements

This research was supported by the Program Management Unit on Area-Based Development (PMU-A), Thailand. The authors would like to thank the Nakhon Phanom Municipality and the Nakhon Phanom Provincial Disaster Prevention and Mitigation Office for their valuable cooperation, technical support, and assistance in field data collection and system deployment. Their contributions were essential to the successful completion of this research.

Author Contributions: “Conceptualization, S.K. and K.R.; methodology, S.K. and K.R.; software, S.K. and K.R.; validation, S.K. and K.R.; formal analysis, S.K.; investigation, S.K. and K.R.; resources, S.K.; data curation, S.K.; writing—original draft preparation, B.B.; writing—review and editing, B.B.; visualization, B.B. and C.Y.; supervision, K.M. and K.P.; project administration, K.M. and K.P.; funding acquisition, K.M. and K.P.

Funding: This research was financially supported by the Program Management Unit on Area-Based Development (PMU-A), Thailand in a project grant no. A11F680143.

Conflicts of Interest: The authors declare no conflict of interest.

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Integrating Geographic Information System and Logistic Regression for Forest Fire Susceptibility Mapping in Chom Thong District, Chiang Mai Province, Thailand

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Abstract: Forest fires are a major environmental concern in Northern Thailand, contributing to ecosystem degradation, biodiversity loss, and air pollution. Despite numerous wildfire susceptibility studies worldwide, limited research has applied interpretable statistical models to identify key environmental drivers of forest fire occurrence in mountainous landscapes of Northern Thailand. This study aimed to identify the environmental factors influencing forest fire occurrence and develop a forest fire susceptibility map using an integrated Geographic Information System (GIS) and Logistic Regression (LR) framework in Chom Thong District, Chiang Mai Province, Thailand. Forest fire occurrence data were derived from active fire hotspots detected by the Suomi-NPP VIIRS sensor during 2023–2025. A total of 1,674 hotspots were identified, with the highest number recorded in 2024 (889 hotspots). Ten environmental variables, including elevation, slope, aspect, topographic wetness index (TWI), stream density, rainfall, normalized difference vegetation index (NDVI), modified normalized difference water index (MNDWI), land sur-face temperature (LST), and land use, were analyzed. Logistic regression modeling was performed using 2,293 training samples (70%) and validated using 983 testing samples (30%). The results revealed that slope, rainfall, stream density, and LST were significant predictors of forest fire occurrence. The forest fire susceptibility map classified 235.12 km^2 (21.16%) as very high susceptibility and 204.16 km^2 (18.38%) as high susceptibility, primarily concentrated in mountainous forest areas. Model validation yielded an overall accuracy of 77.5% and an AUC value of 85.2%, indicating good predictive performance. The developed susceptibility map provides a practical GIS-based framework for forest fire prevention planning and environmental management in Northern Thailand.

Keywords: forest fire; logistic regression; forest fire risk mapping; remote sensing; GIS; disaster risk

Detection of Radon Anomalies for Earthquake Precursors Using Statistical and Machine Learning Methods: A Preliminary Study from the Mae Chan Fault Zone, Northern Thailand

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Abstract: Radon emissions are well known as potential geophysical precursors to seismic activity. This study presents initial baseline data from a newly established continuous radon monitoring station in Mae Chan, Chiang Rai, northern Thailand, from January 31 to July 27, 2025. The station began operation before the Mw 7.7 earthquake of 28 March 2025, providing a rare opportunity to examine radon behavior surrounding a major seismic event. Radon in soil (Radon_A) and air (Radon_B) is evaluated using a single-parameter approach that intentionally excludes meteorological corrections to isolate the raw predictive signal and establish a baseline before multi-parameter models are developed; some flagged anomalies may reflect environmental rather than tectonic causes. Four anomaly detection methods are compared: Z-score, interquartile range (IQR), 99th percentile, and Isolation Forest. Unlike threshold-based methods targeting upper-tail extremes, Isolation Forest detects contextual anomalies through structural isolation in feature space and has not been previously applied to radon monitoring in this region. The algorithm detected soil radon anomalies up to 72 days before the Mw 7.7 event, whereas Z-score, IQR, and 99th percentile methods identified no precursory signals. Although the six-month period limits definitive causal interpretation, a 72-day lead time is practically significant, allowing authorities time to heighten surveillance and mobilize emergency response plans. These findings establish a baseline characterization of radon dynamics at the Mae Chan fault zone and demonstrate the promise of unsupervised machine learning for geophysical anomaly detection in Southeast Asia, providing a foundation for radon-based earthquake early warning systems and supporting continued long-term fault monitoring.

Keywords: radon precursor; earthquake; Isolation Forest; anomaly detection; Mae Chan fault; northern Thailand

A Conceptual Framework for Climate Risk Management Integrating Sustainability Disclosure and Catastrophe Bonds: Implications for Thailand with International Evidence

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Abstract: With the acceleration of climate change and the rapid development of international sustainability disclosure standards such as IFRS S1/S2 and ISSB, emerging economies face increasing challenges in climate risk management and financial stability. This study proposes a conceptual framework integrating sustainability disclosure and catastrophe bonds (CAT bonds), with a focus on policy implications for Thailand. Drawing on international case studies—including Mexico's MultiCat program, Hong Kong's dual-trigger CAT bonds, and the Insurance-Linked Securities (ILS) markets in the US and Europe—this research explores how capital markets can facilitate effective risk transfer. It further examines how standardized climate disclosures enhance transparency and support risk pricing and financial innovation. The study suggests that Thailand can strengthen its climate resilience through an integrated framework of "disclosure–assessment–transfer–resilience." Policy recommendations include enhancing climate disclosure systems, developing catastrophe risk databases, and adopting multi-layered risk financing mechanisms.

Keywords: Climate Risk, CAT Bonds, Sustainability Disclosure, IFRS S2, Thailand

Climate Risks and Long-Term Well-Being in Thailand: A Comparative Regional Environmental Geography Analysis through the Sufficiency Economy Philosophy

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Abstract: Climate change intensifies both chronic and episodic environmental risks, producing uneven long-term exposure patterns across regions. This study examines how differentiated climate and environmental risks in Thailand influence long-term well-being and adaptive sustainability, and how the Sufficiency Economy Philosophy (SEP), a Thai-origin framework, may function as a localized adaptive complement within environmental geography and climate adaptation studies. Four purposively selected regions – Chiang Mai, Bangkok, Rayong, and Phuket/Songkhla – were analysed using secondary longitudinal datasets comprising IQAir and Pollution Control Department (PCD) PM2.5 records (2017–2025), Gulf of Thailand tide-gauge sea-level trends, peer-reviewed wildfire hotspot records, and official tsunami casualty data. Exposure indicators – PM2.5 concentrations, sea-level rise rates, hotspot counts, and hazard-event records – were independently verified against named sources, and SEP was applied analytically within each regional case rather than only in the conclusion. Findings suggest that chronic low-intensity exposure, such as Chiang Mai's recurring seasonal haze and Bangkok's compounded air pollution and flooding, generates cumulative well-being pressures differing significantly from episodic catastrophic hazards such as the 2004 Indian Ocean tsunami. Regional adaptive capacity, rather than exposure alone, strongly influences long-term resilience outcomes: Rayong's industrially concentrated coastal corridor, within Thailand's Eastern Economic Corridor (EEC), exhibits comparatively weaker environmental monitoring coverage despite growing cumulative risk. SEP's principles of moderation, resilience, balanced development, risk awareness, and sustainable resource use provide a regionally grounded complement to international climate-adaptation and disaster-risk-reduction frameworks. Sustainable adaptation requires a shift from reactive disaster management toward anticipatory, spatially differentiated resilience, particularly in regions facing uneven environmental vulnerability.

Keywords: spatial vulnerability; environmental geography; regional exposure patterns; climate change and well-being; Sufficiency Economy Philosophy; long-term environmental exposure; Thailand

A Methodological Framework Integrating Fuzzy Delphi, CFA, and SEM for Developing Disaster-Resilient Green Supply Chain Models under ESG Contexts

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Abstract: Increasing climate risks and supply chain disruptions have highlighted the need for integrated approaches that strengthen disaster resilience under Environmental, Social, and Governance (ESG) contexts. While Fuzzy Delphi Method (FDM), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM) are widely applied individually in supply chain and sustainability research, few studies have proposed a systematic procedure that integrates these three methodologies into a coherent research framework. This study proposes a methodological framework for developing a disaster-resilient green supply chain model by integrating a three-stage analytical procedure comprising FDM, CFA, and SEM. Rather than conducting a statistical meta-analysis or collecting new empirical data, the study synthesizes the logical relationships established across three sequential empirical studies that investigated the same research population and constructs. In this framework, FDM is employed to identify and refine key ESG and green supply chain constructs, CFA is subsequently applied to validate the measurement model, and SEM is used to examine the structural relationships among the validated constructs. The integration represents a conceptual and methodological modeling process rather than a simple literature review or pooled statistical analysis. The proposed framework establishes a systematic research procedure that enables researchers to progress from construct identification to measurement validation and structural relationship testing. Although this study does not report new empirical statistics, it demonstrates how the three analytical methods can be logically integrated into a unified research process. Future empirical applications of this framework should validate the proposed model using factor loadings, model fit indices, path coefficients, and other statistical indicators to confirm its applicability and robustness. The proposed methodological framework provides a practical reference for researchers and practitioners seeking to develop disaster-resilient green supply chain models under ESG contexts and contributes a structured analytical process that can improve the rigor and consistency of future sustainability and disaster resilience research.

Keywords: ESG, Green Supply Chain; Disaster Risk Management; Resilience; Fuzzy Delphi; CFA; SEM

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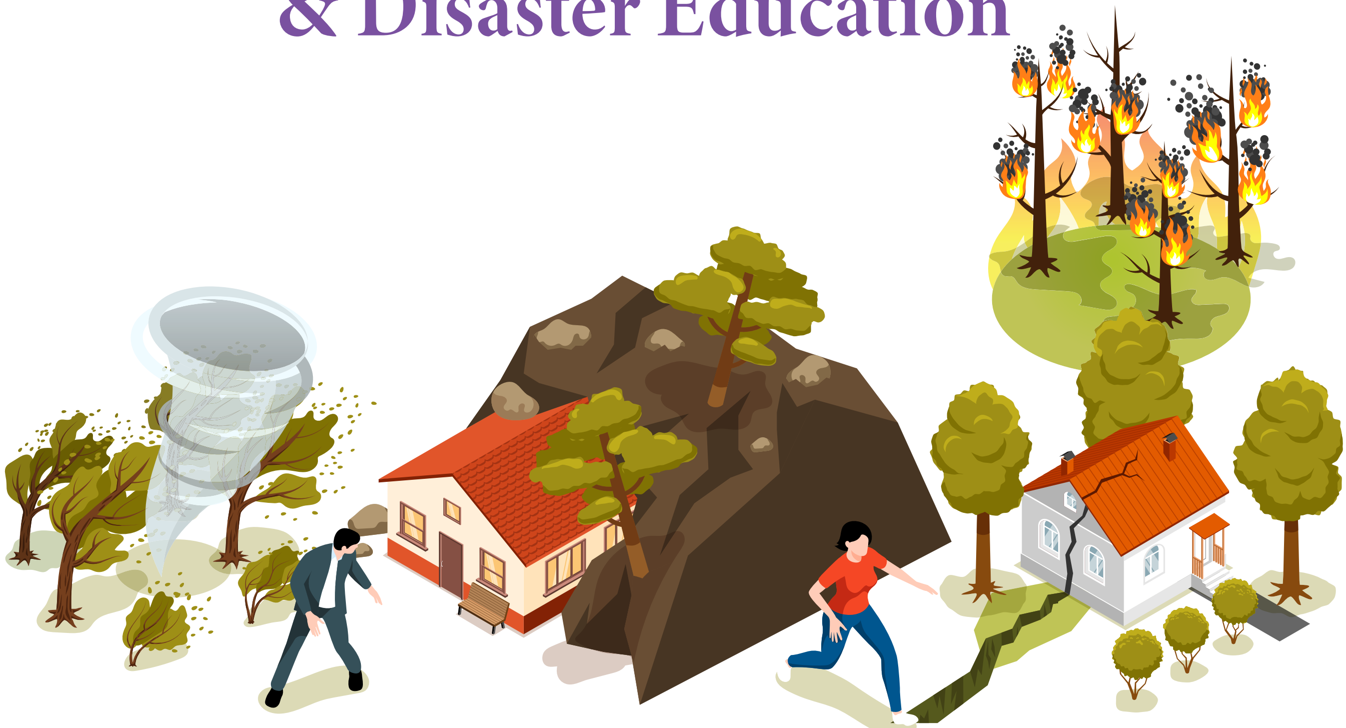

Developing Systemic Management Mechanisms for Water Resource Management and Enhancing Competencies of Local Administrative Organizations and Water User Agencies: Lessons Learned

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Abstract: This study aimed to analyze lessons from the research in five pilot provinces: Chiang Rai, Rayong, Roi Et, Pattani, and Nakhon Pathom, where each researcher team attempted to establish a provincial data center. It would synthesize success factors, bottlenecks, and scalable directions for developing systemic provincial mechanisms for integrated water resources management. The research applied a qualitative methodology, including Participatory Action Research, and focus groups, guided by adaptive co-management, experiential learning, outcome mapping, and developmental evaluation. The findings show that the project did not yield a single transferable model across all provinces; instead, it identified multiple context-specific development pathways. Nakhon Pathom showed the strongest progress in linking data to plans and projects; Chiang Rai in data platforms and early warning; Pattani in disaster command and GIS-based coordination; Rayong in institutional and data-system design; and Roi Et in implementation-ready organizational design built on existing structures. Cross-case analysis shows that neither data provision nor training alone is sufficient for fundamental change. Sustainable provincial water governance requires a clearly designated host unit, dedicated personnel, cross-level coordination mechanisms, data platforms usable in both normal and crisis conditions, and channels that connect local evidence to provincial and national planning and budgeting systems. The study shows that scale-up should focus on transferring design principles rather than replicating a single organizational template. The proposed core model of a provincial water resource management center comprises four interrelated axes: data, analysis, coordination, and decision- and plan-driving. Major policy implications involve establishing or strengthening permanent provincial water structures, developing shared provincial data systems, creating workable SOPs and workflows, building continuous competency systems, and reforming legal and policy arrangements to unlock local roles in integrated, viable water governance.

Keywords: integrated water resources management; decision support system; provincial water governance

The Effects of a School-Based Disaster Education Program in Improving Earthquake Preparedness among Junior High School Students in Indonesia

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Abstract: Indonesia is one of the most disaster-prone countries due to its geological location, making earthquake preparedness essential, particularly for adolescents. However, disaster preparedness among students remains inadequate due to limited education and training. This study aimed to determine the effect of a School-Based Disaster Education Program (DEP) on junior high school students' knowledge and attitudes in facing earthquake disasters in Indonesia. A quasi-experimental pretest–posttest control group design was conducted in two junior high schools in Bukittinggi City, West Sumatra, Indonesia, in 2024. Sample size was calculated using power analysis (effect size $d = 0.65$, $\alpha = 0.05$, power = 0.80), yielding a minimum of 32 participants per group. To account for attrition, 72 students were recruited and equally assigned to an experimental group ($n = 36$) and a control group ($n = 36$) using purporsive sampling. The school-based DEP intervention was delivered over two sessions and consisted of three main components: (1) interactive classroom-based education covering earthquake risk, preparedness measures, and safety procedures; (2) audiovisual learning through educational videos demonstrating appropriate responses during earthquakes; and (3) practical evacuation simulations, allowing students to rehearse safe evacuation and emergency responses in a structured school setting. The control group received standard curriculum-based instruction without additional disaster education. Data were collected using validated questionnaires on knowledge and attitudes, demonstrating acceptable validity ($r > 0.349$) and reliability ($\alpha > 0.80$). Paired and independent t-tests were applied after confirming normality and homogeneity assumptions. Result of the study showed that the mean knowledge and attitude scores in the experimental group after the intervention were significantly increased than before receiving the intervention ($p < 0.05$). Both scores also significantly higher than particpants in the control group ($p < 0.05$). In conclusion, the Disaster Education Program (DEP) effectively enhances students' knowledge and attitudes toward earthquake preparedness. This program is recommended for broader implementation as part of school-based disaster risk reduction strategies and it can be integrated into extracurricular activities.

Keywords: Knowledge; Attitude; Disaster Education Program (DEP); Earthquake; Junior High School Students

Long-Term Effects of a Resilience and Coping Intervention (RCI) on Self-Esteem Among Individuals with Amphetamine Use Disorder

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Abstract: Amphetamine use is associated with adverse mental health outcomes, including low self-esteem, a significant risk factor for relapse. This study evaluated the long-term effectiveness of a Resilience and Coping Intervention (RCI) in improving self-esteem among individuals with amphetamine use disorder. A quasi-experimental study with follow-up assessments at 3 and 6 months post-intervention was conducted. Eligible participants, including adolescents and young adults, were purposively recruited and randomly assigned to either the experimental group (n = 34) or the control group (n = 34). The experimental group received the 3-week RCI in addition to standard care, whereas the control group received standard care alone. Self-esteem was measured using the Revised Thai Rosenberg Self-Esteem Scale. Data were analyzed using independent-samples t tests and analysis of covariance (ANCOVA). Immediately after the intervention, participants in the experimental group demonstrated significantly higher self-esteem scores than at baseline and than those in the control group. These improvements were maintained at both the 3-month and 6-month follow-up assessments. Self-esteem remained significantly higher than both baseline and the control group at each follow-up time point. No significant difference was observed between the 3-month and 6-month follow-up assessments, indicating that the intervention effects were sustained over time. These findings suggest that the RCI is an effective adjunct to standard care for improving self-esteem among individuals with amphetamine use disorder. Integrating this intervention into psychiatric nursing practice and rehabilitation services may enhance long-term recovery and reduce the risk of relapse.

Keywords: Amphetamine Users, Coping, Life ResilienceLong-Term, Effects Self-Esteem

Application of ADAPT-ITT Framework to Translate and Modify the Resilience and Coping Intervention (RCI) for Reducing Depression in Senior High School Students

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Abstract: Depression is prevalent among adolescents undergoing developmental transitions. The Resilience and Coping Intervention (RCI) has been shown to reduce stress and depressive symptoms while enhancing resilience and coping skills. This article describes the cultural adaptation and pilot implementation of the RCI for Thai senior high school students, recognizing that effective cross-cultural implementation requires alignment with the sociocultural, linguistic, and contextual characteristics of the target population. The ADAPT-ITT (Assessment, Decision, Administration, Production, Topical Experts, Integration, Training, and Testing) framework was used to systematically adapt the original English-language RCI for the Thai context. The adapted program was piloted in a senior high school in northeastern Thailand to evaluate its preliminary effectiveness in reducing depressive symptoms. A total of 84 students were assigned to either the experimental or control group (n = 42 each). The adapted RCI demonstrated excellent content validity, with an Item-Objective Congruence (IOC) index of 0.92. Following the intervention, students in the experimental group demonstrated significantly lower depression scores than at baseline and compared with the control group. They also showed significantly higher resilience scores than at baseline and compared with the control group. These findings suggest that the ADAPT-ITT framework provides a systematic and effective approach for culturally adapting the RCI while preserving its core components. Integrating psychological, spiritual, and sociocultural perspectives enhanced the program's relevance and acceptability, supporting its implementation in new cultural settings.

Keywords: ADAPT-ITT; Modification; Resilience and Coping Intervention (RCI)

The Thai Version of the Resilience and Coping Intervention (RCI): A Narrative Review of Its Feasibility, Cultural Suitability, and Effectiveness in Thailand

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Abstract: The Thai version of the Resilience and Coping Intervention (RCI) is a culturally adapted psychosocial intervention designed to enhance resilience and adaptive coping among Thai adolescents experiencing psychosocial distress. Grounded in resilience theory, cognitive-behavioral principles, and stress and coping theory, the intervention comprises five core components: understanding stress and emotional responses, cognitive restructuring, adaptive coping skill development, emotional regulation and mindfulness practice, and strengthening social support through structured group activities. This paper aimed to examine the feasibility, cultural suitability, and effectiveness of implementing the Thai RCI in the Thai context. A narrative review was conducted by synthesizing published Thai research on the RCI and related resilience-based interventions. The evidence was analyzed to evaluate the intervention's characteristics, implementation strategies, and psychological outcomes within the Thai sociocultural context. The findings indicate that resilience is a significant protective factor against stress, anxiety, and depressive symptoms among Thai adolescents, while social support and adaptive coping are important determinants of resilience. The intervention aligns well with Thai cultural values, including collectivism, family connectedness, and community support, enhancing its cultural relevance and acceptability. A quasi-experimental study conducted in northeastern Thailand demonstrated that participation in a three-week Thai RCI significantly increased resilience and reduced depressive symptoms immediately after the intervention compared with usual school support. Although these effects diminished at the one-month follow-up, the findings suggest that booster sessions and extended intervention periods may improve long-term effectiveness. Moreover, the group-based format, relatively low implementation cost, and compatibility with school- and community-based mental health services support the intervention's feasibility and scalability. Overall, the Thai RCI is a feasible, culturally appropriate, and evidence-informed intervention for promoting resilience and adaptive coping among Thai adolescents. Future multicenter randomized controlled trials with

extended follow-up are recommended to establish long-term effectiveness and support nationwide implementation.

Keywords: Implementation; Resilience and Coping Intervention (RCI); Thai Context

Ethical Challenges Faced by Healthcare Professionals During the Phases of Disaster Management: A Scoping Review

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Abstract: **Background:** The accelerating frequency and severity of Natural disasters have overwhelmed existing disaster management measures, creating significant gaps with profound ethical implications across all phases of the disaster cycle. As national and local authorities prepare for and respond to disasters amid associated ethical tensions, understanding these dilemmas is essential for anticipating health needs, planning workforce capacity, and designing ethically robust responses that can withstand the escalating demands of disasters. This review aimed to map the existing literature regarding the ethical challenges encountered by healthcare professionals across the various phases of flood disaster management. **Method**. Multiple databases were searched, including Scopus, PubMed, and CINAHL, using a defined search strategy that included all variables in the PCC framework. This ScR was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to identify peer-reviewed studies and grey literature that detail ethical issues or dilemmas in the flood disaster management cycle, published from 2000 to 2026. Whilst studies with no ethical dimension and non-professional audiences were excluded from the review to answer the question of the ethical issues encountered by healthcare professionals during the different phases of flood disaster management. The quality of included studies was assessed by two independent reviewers using the JBI appraisal tool, focusing on methodological quality, trustworthiness and relevance to the study design. The included studies were categorised by study design, population characteristics, country, disaster type, and disaster management phase. A narrative and thematic synthesis approach was used to map the existing evidence. The emerging patterns and concepts were organised by disaster management phase. While the final synthesis was reviewed by the research team for coherence and completeness. **Results:** A total of 1147 records were identified through three database searches. After removing duplicates and screening titles/abstracts,22 full-text articles were assessed for eligibility. Finally, 14 studies met the inclusion criteria and were included in the review, representing diverse designs such as qualitative, mixed-methods, and review studies, and spanning multiple countries, including Nepal, Turkey, India, Iran, and Ethiopia. Across these studies, sample sizes ranged from small qualitative groups of 12 health providers to large literature-based evidence sets of 44 articles. The synthesis of existing literature reveals that ethical challenges in disaster management permeate every phase of the disaster cycle, most especially in the response phase. In the mitigation and preparedness phases, ethical tensions arise from the fair allocation of limited resources amid extreme uncertainty. The response phase is dominated by acute triage dilemmas and moral distress, as health professionals struggle to balance their duty to care with personal safety. Finally, the recovery phase presents ethical risks, including persistent moral distress and decisions about resource redistribution. **Conclusion:** This review highlights a critical need for an ethically sensitive framework to support healthcare workers in navigating a difficult shift from individual clinical care to population-based utilitarianism, and effective leadership to ensure fair decision-making processes and the preservation of community trust necessary for long-term resilience

Keywords: Natural disaster, Disaster Management; Healthcare Professionals; Decision Making; Ethics; Moral Distress.

Enhancing Disaster Nursing Education Through Simulation-Based Learning: A Mass Casualty Incident Experience

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Abstract: Developing disaster nursing competencies is essential to prepare nursing students to respond effectively to mass casualty incidents (MCI). Simulation-Based Learning (SBL), as a learning innovation, provides realistic and safe learning experiences that enhance students' clinical competence, critical thinking, and decision-making. This study aimed to develop and implement an SBL model for MCI management as an innovative teaching strategy, evaluate its effectiveness by comparing students' final course grades with those of a historical control group from the previous academic year, and describe students' reflections on their learning experiences after participation in the simulation. A retrospective quasiexperimental study with a historical control group was conducted. The intervention group included the entire population of 60 third-year nursing students enrolled in the Disaster Nursing course at the Faculty of Nursing, Thaksin University, during the academic year 2025. The historical control group consisted of students who completed the same course in the previous academic year. The innovation in SBL learning consisted of three phases: preparation, implementation, and evaluation, and its effectiveness was evaluated by comparing the distribution of final grade grades of the course between the intervention and historical control groups using the independence chi-square test. The distribution of final grades differed significantly between the historical cohort (N = 57) and the current intervention cohort (N = 60). In the historical cohort, 1.79% (1/57) of the students achieved grade A and 19.30% (11/57) achieved grade B +, while in the current intervention cohort, 25.00% (15/60) achieved grade A and 56.67% (34/60) achieved grade B +. A chi-square test of independence revealed a statistically significant association between cohort and final grade distribution, $\chi^2(2, N = 117) = 44.60$, $p < .001$. Compared to the historical cohort, students in the current intervention cohort demonstrated substantially higher proportions of Grade A and Grade B+ and a correspondingly lower proportion of lower grades. In conclusion, Simulation-Based Learning (SBL), as a learning innovation, significantly improved student learning outcomes in disaster nursing education compared to the historical control group. Students' reflections further suggest that SBL may enhance professional confidence and essential nontechnical competencies, including decision-making, leadership, communication, and teamwork. Future research should employ prospective quasi-experimental classroom designs with matched comparison groups and validated outcome measures to further strengthen the evidence for the educational effectiveness of SBL.

Keywords: Simulation-Based Learning, Mass Casualty Incident, Disaster Nursing, Learning Outcomes, Nursing Education, Triage;

Experiences of transformative learning of nursing students participating in flood disaster relief during the 2025 Hat Yai Floods, Southern Thailand: A qualitative study

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Abstract: Flood disasters occur frequently in southern Thailand, causing significant impacts on communities and healthcare systems. Nursing students often participate in disaster relief activities; however, there is limited evidence on how such experiences contribute to their professional development and learning outcomes. This study aims to explore the transformative learning experiences of nursing students who participated in flood disaster relief activities in Hat Yai, Southern Thailand. A qualitative descriptive study was conducted with 10 nursing students who volunteered in flood disaster relief operations. Data were collected through semi-structured interviews and analyzed using thematic analysis. Data collection continued until data saturation was achieved. Trustworthiness was ensured through member verification, peer debriefing, and maintaining an audit trail. Participants were selected using purpose-sampling based on their direct involvement in disaster response activities. The findings revealed four major themes: (1) Development of professional identity through real-world nursing practice; (2) Improvement of leadership and teamwork skills in disaster response settings; (3) Increased awareness of community needs and social responsibility; and (4) Integration of theoretical knowledge with practical disaster management experiences. The findings suggest that structured participation in disaster relief activities can serve as a transformational experiential learning strategy to strengthen nursing competencies, leadership capacity, and disaster preparedness. These findings have implications for integrating experiential disaster response learning into undergraduate nursing curricula to improve workforce readiness and community resilience. Future studies should include larger and more diverse samples and evaluate the long-term educational outcomes of disaster-based learning experiences. Integrating disaster response experiences into nursing curricula may improve the readiness of the workforce for future emergencies.

Keywords: Nursing students, Disaster nursing, Flood disaster, Transformative learning, Qualitative study

Validation and Reliability of the Nurses' Satisfaction with Nursing Practice in Promoting Patients' Spiritual Well-Being During Hospitalization Tool (NSNP-PSWH Tool): A Preliminary Study

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Abstract: Assessing nurses' satisfaction with nursing practice in promoting patients' spiritual well-being is essential for strengthening holistic care. However, there is a lack of instruments specifically designed to measure this construct. Reliable and valid measurement tools are needed to accurately assess nurses' experiences and inform evidence-based interventions. The Nurses' Satisfaction with Nursing Practice in Promoting Patients' Spiritual Well-Being During Hospitalization Tool (NSNP-PSWH Tool) is a newly developed instrument to address this gap. Therefore, this study aimed to to develop and conduct preliminary testing to examine its validity and reliability among clinical nurses. A methodological and cross-sectional design was employed, involving content validity and reliability testing. The NSNP-PSWH Tool was developed based on literature related to spiritual nursing care and holistic practice, which consist of nine items categorized into four conceptual domains: (1) practice and care delivery, (2) interpersonal and collaborative aspects, (3) organizational and environmental support, and (4) overall satisfaction. Content validity was assessed using the Content Validity Index (CVI) by three experts. Preliminary item analysis was conducted using item–total correlations and the internal consistency reliability was evaluated using Cronbach's alpha coefficient among a sample of 30 nurse participants at inpatient ward of an Islamic hospital in Indonesia. The results showed that all items were rated as relevant by the experts and had a content validity index of 1.00 (I-CVI = 1.00; S-CVI = 1.00). Item–total correlations ranged from .586 to .831 ($p < .01$), indicating acceptable internal consistency at the item level, and Cronbach's alpha coefficients was α = .899 indicating high reliability of the instrument. These findings provide preliminary evidence supporting the internal consistency and content relevancy.of the NSNP-PSWH Tool. However, the dimensional structure of the instrument has not yet been confirmed. Further studies with larger samples are needed to conduct factor analysis and evaluate its psychometric properties.

Keywords: validation, reliability, nursing practice, nurses' satisfaction, spiritual well-being, instrument development

Spatiotemporal Analysis and Socio-Climatic Factors of Leptospirosis in Trang, Thailand (2017–2024): Implications for Climate Change Adaptation and Anti-Fragile Health Systems

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Abstract: Leptospirosis is a climate-sensitive zoonosis whose transmission is linked to flooding, rainfall, soil moisture, and agricultural exposure, and a major public health problem in Trang, where the morbidity rate has increased continuously. This ecological study aimed to analyze the spatiotemporal patterns of leptospirosis, identifying associated factors to inform locally targeted interventions. Using 2017–2024 multisource secondary subdistrict-level data, Spatial Empirical Bayes–smoothed incidence rates were analyzed for global and local spatial autocorrelation with Moran's I and Local Indicators of Spatial Association (LISA) using a 3 k-nearest-neighbour weights matrix. Factors were compared across LISA clusters using Kruskal–Wallis and Chi-square tests, and a negative-binomial generalized linear mixed model (GLMM) with subdistrict and month random effects was fitted to monthly case. Provincial incidence increased from 25.52 per 100,000 population in 2017 to 50.60 in 2024. Significant positive spatial autocorrelation was detected in every year (Moran's I 0.289–0.760, $p \leq 0.002$), with recurrent hotspots in agricultural, higher-elevation areas. Twelve continuous factors and flood-prone status differed significantly across clusters ($p < 0.05$). In the GLMM, higher percentages of flooded and agricultural areas, cattle density, elevation, and minimum temperature were associated with increased cases, whereas higher pig density, maximum temperature, and urban residence were associated with fewer cases. Leptospirosis risk in Trang is spatially structured and shaped by interacting agro-environmental and climate-induced disaster conditions, underscoring the urgent need for transdisciplinary, spatially targeted, and nature-based measures to strengthen disease prevention and control, and cultivate anti-fragile health and food systems.

Keywords: leptospirosis; climate change adaptation; anti-fragility; disaster risk management; spatiotemporal analysis; Local Indicators of Spatial Association (LISA); generalized linear mixed model (GLMM); Trang

Smart Monitoring and Community Co-learning: AI-Enabled Disaster Awareness Enhancement for Global Resilient Communities

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Abstract: As climate change intensifies the frequency and severity of natural disasters, strengthening disaster awareness at the community level has become increasingly critical. This study explores the integration of Artificial Intelligence (AI) and knowledge management into disaster education through a case study of Jinwen University of Science and Technology and the adjacent SinDian Dasyueshisiang Community in New Taipei City, Taiwan. The study adopts a case study approach to examine the design and implementation of an AI-supported community disaster education model. The proposed system integrates GNSS-based ground displacement monitoring, rainfall and flow sensors, and a centralized AI platform incorporating Random Forest and LSTM algorithms to support disaster monitoring and early warning. Rather than evaluating AI model performance experimentally, this study focuses on the framework design, system integration process, and community engagement strategies. The case demonstrates how AI technologies can be combined with participatory learning and local knowledge to support disaster awareness and community resilience. The proposed framework provides a practical reference for integrating campus resources with surrounding communities and offers a transferable model for disaster education in Southeast Asia, particularly in flood-prone regions of Thailand facing increasing climate-related risks.

Keywords: smart monitoring; disaster awareness; resilient; co-learning

Bridging Traditional Knowledge and Modern Governance: A Framework for Strengthening Earthquake Resilience in Vanuatu

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Abstract: Vanuatu is one of the most disaster-prone countries in the world due to its location along the Pacific Ring of Fire, making it highly vulnerable to earthquakes, volcanic eruptions, tsunamis, cyclones, and other natural hazards. While modern disaster risk reduction (DRR) strategies and governance mechanisms have improved preparedness and response capacities, indigenous practices provide valuable insights into hazard recognition, preparedness, coping mechanisms, and community recovery. However, the integration of traditional knowledge into formal governance frameworks remains limited. This study investigates how traditional knowledge and modern governance can be effectively bridged to enhance earthquake resilience in Vanuatu. Semi-structured interviews were conducted in 2025 in two islands: Tanna Island and Efate Island (Port Vila). Tanna was selected because of its strong traditional knowledge systems and history of coping with natural hazards, while Efate, particularly Port Vila, was selected because it is the administrative and economic center of Vanuatu and has experienced significant earthquake and tsunami impacts in recent years. A total of 100 participants were involved in the study. The collected knowledge was sorted out through participatory card-sorting exercises . Among the five disaster phases, nearly 40% of traditional knowledge pieces were about the preparedness phase. This knowledge typically includes observation of unusual natural geological phenomena and animal behavior. Areas along the coastal zones of both islands showed a high concentration of traditional knowledge developed through generations of experience with earthquakes, tsunamis, volcanic activity, and other natural hazards. In contrast, Port Vila on Efate Island represented the concentration of modern governance and technological resources. The study then provided policy implications for incorporating traditional and modern knowledge to improve disaster preparedness.

Keywords: Earthquake Resilience; Disaster Risk Reduction; Indigenous Knowledge; Governance; Community Resilience; Vanuatu.

The effect of molding condition on properties of natural rubber sponge for life jacket

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Abstract: Phatthalung Province, Thailand, is frequently affected by monsoons originating from both the Andaman Sea and the Gulf of Thailand. The province's topography slopes from west to east, with the Banthat Mountain Range located to the west and Songkhla Lake to the east. Consequently, prolonged flooding frequently occurs during the monsoon season, particularly in Khuan Khanun, Khao Chaison, and Bang Kaeo districts, where life jackets are essential for emergency response and public safety. This study investigated the effects of molding temperature and degree of vulcanization on the specific gravity, mechanical properties, and morphological characteristics of natural rubber foam for life jacket applications. Natural rubber foam compounds were prepared by compression molding at temperatures of 140, 150, and 160 °C. At each molding temperature, vulcanization levels corresponding to 40, 60, 80, and 100% cure were selected based on cure characteristics determined using a Moving Die Rheometer (MDR). The compounds were molded in a 150 × 150 × 2 mm cavity under a pressure of 10 MPa to achieve the desired curing conditions. Tensile properties were evaluated using a Universal Testing Machine with C-type dumbbell specimens in accordance with ASTM D412, while the foam morphology was characterized using scanning electron microscopy (SEM). The results showed that increasing the degree of vulcanization increased the density of the natural rubber foam from 0.40 to 0.70 g/cm^3 and also improved its tensile strength. Among the processing conditions investigated, molding at 150 °C with an 80% degree of cure was identified as the optimum condition for life jacket applications. This condition produced the lowest foam density while maintaining a tensile strength of 4.88 MPa. Furthermore, flotation tests confirmed that the developed natural rubber foam was capable of functioning as a life jacket. Although its flotation performance differed from that of commercially available life jackets, the material demonstrated promising potential as an alternative buoyant material for flood emergency applications.

Keywords: Life jacket, Natural rubber sponge, Rubber molding condition

Growth Performance of Naked Neck and Thai native Crossbred Chickens Reared under a Cage Production System

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Abstract: Raised-cage rearing of indigenous chickens may support rapid poultry production recovery in flood-prone areas by reducing flood exposure and optimizing limited production space, thereby enhancing post-disaster livelihoods and household food security. This study evaluated the growth performance of Naked Neck chickens and Thai native crossbred chickens (Chaiyaree) reared under a cage production system. A total of 800 mixed-sex chickens at 4 weeks of age, comprising 400 Naked Neck chickens and 400 Chaiyaree chickens, were used in the experiment. For each breed, birds were allocated to five replicates of 80 chickens and distributed among ten farmers. Chickens were fed a commercial diet containing 21% crude protein ad libitum. Body weight, feed conversion ratio (FCR), and survival rate were measured between 60 and 75 days of age to evaluate growth performance. The production index was compared between the two breeds using an independent-samples t-test. The results showed that Chaiyaree chickens achieved a final body weight of 1.83 kg, an FCR of 2.65, and a survival rate of 91.00%, compared with 1.76 kg, 3.40, and 82.50%, respectively, in Naked Neck chickens. Consequently, the production index was significantly higher in Chaiyaree chickens than in Naked Neck chickens (102.23 vs. 56.85, $P < 0.01$). These findings indicate that Chaiyaree chickens exhibited superior growth performance and production efficiency under cage-rearing conditions, suggesting that this breed may be better suited to cage-based production systems for supporting resilient poultry production and post-disaster livelihood recovery in flood-prone areas.

Keywords: Naked Neck chicken; Thai native crossbred chickens; growth performance; cage rearing system

The 2nd International Conference
on Disaster Risk Management
for Strengthening Resilience and Sustainability
in Communities 2026
(ICDRM2026)

ISBN (e-book) 978-974-474-116-5
copyright © 2026
First printing July 2026

Published by Research and Development Institute, Thaksin University
222 Village No. 2, Ban Phrao Subdistrict, Pa Phayom District,
Phatthalung Province 93210

www.tsu.ac.th

ICDRM2026

Thaksin University