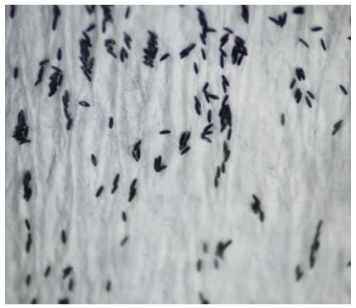
Transforming Community Dengue Early Warning System (C-DEWS) Using Multimodal Federated Learning for Dengue Hotspot Prediction and Risk Assessment

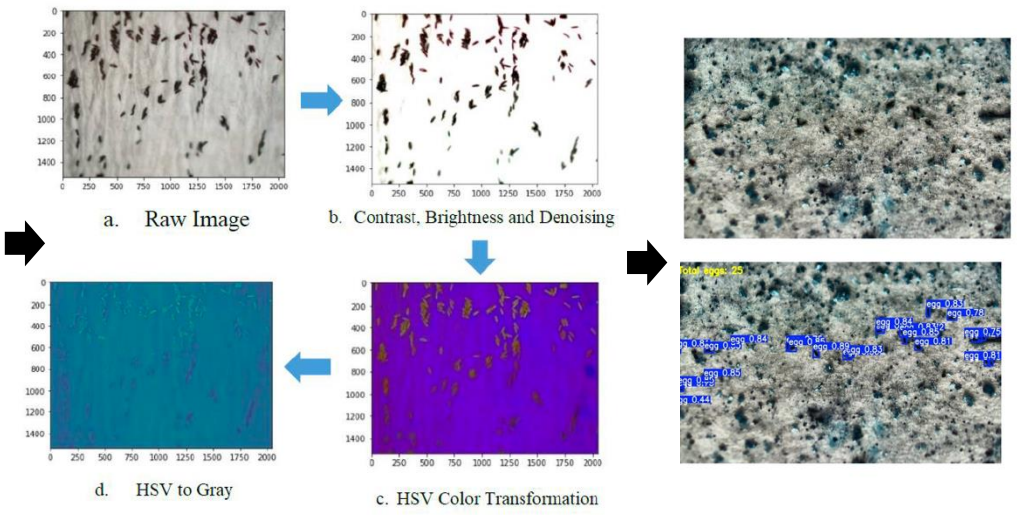
Prof. Dr. Betchie E. Aguinaldo, DIT

Project Title: Transforming Community Dengue Early Warning System (C-DEWS) Using Multimodal Federated Learning for Dengue Hotspot Prediction and Risk Assessment

Background:

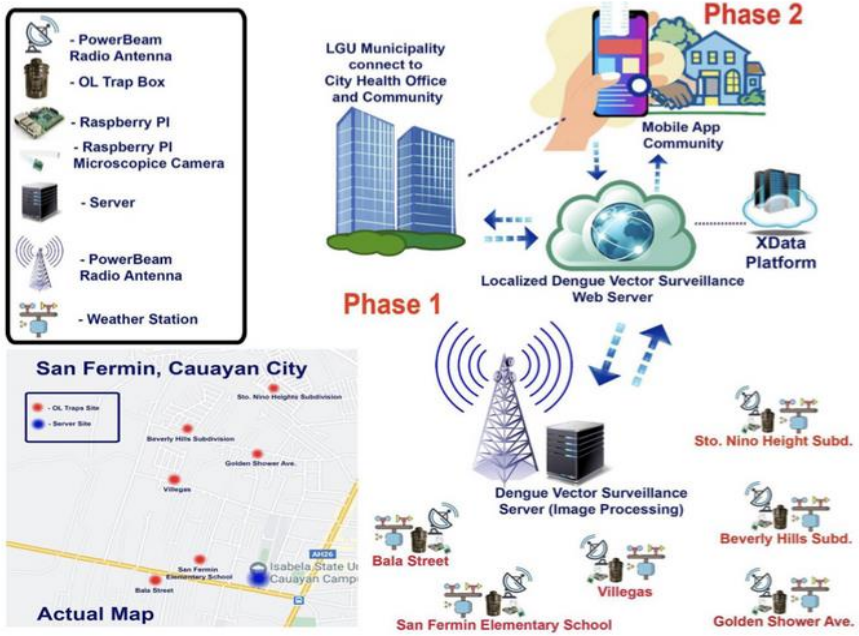


L: 0.58 mm; W: 0.17 mm

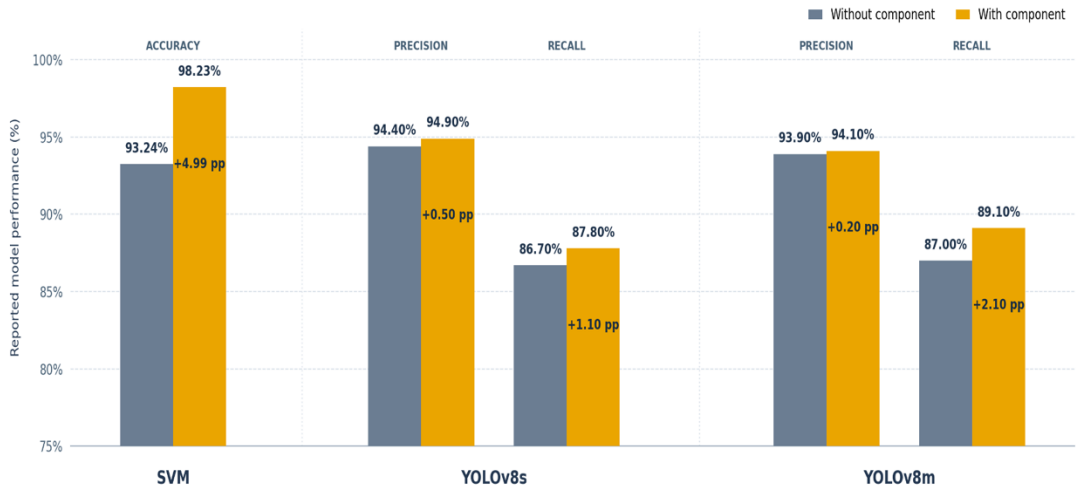


SVM

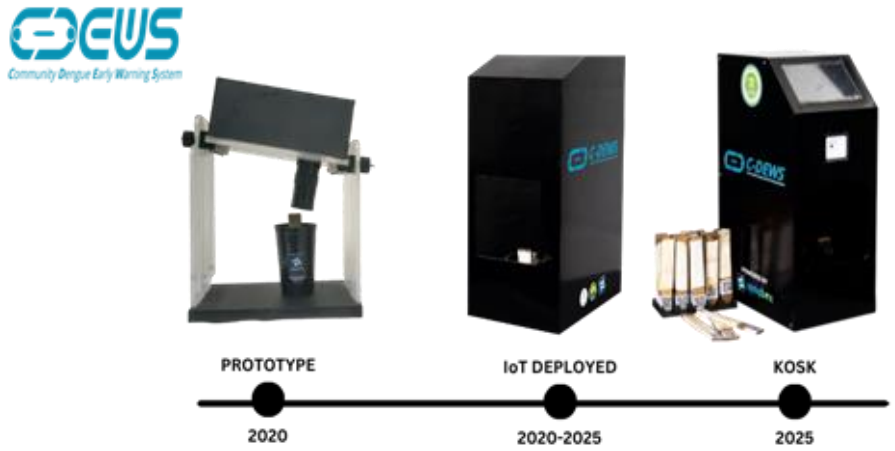
YOLOv8m



Overall Concept (ASEAN IVO 2020)

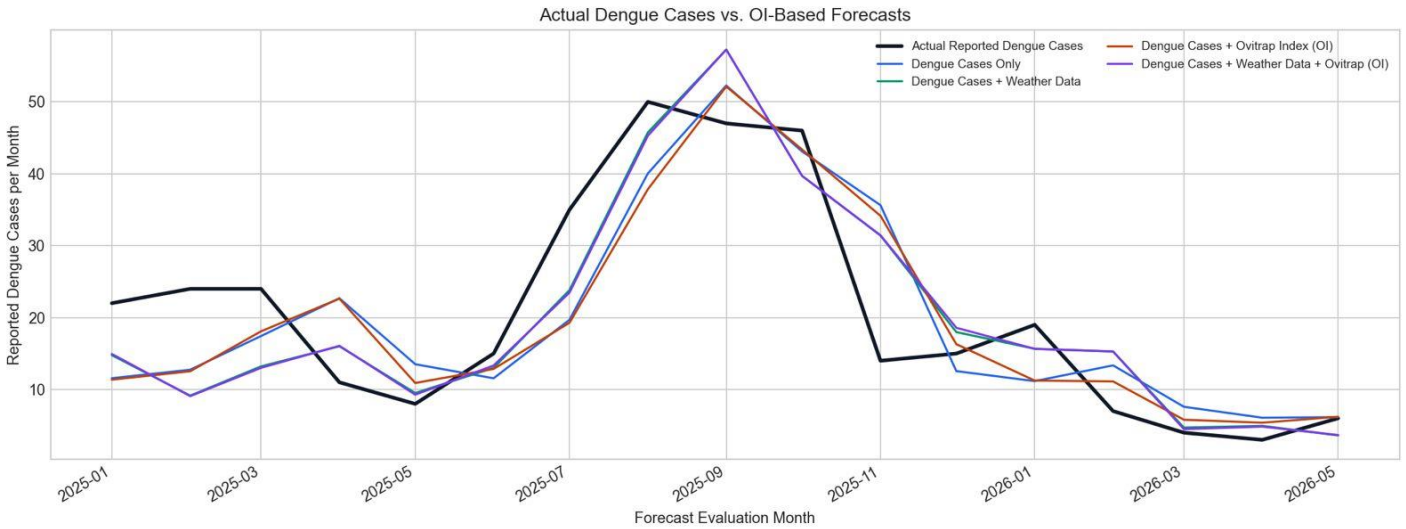


Egg Detection Results

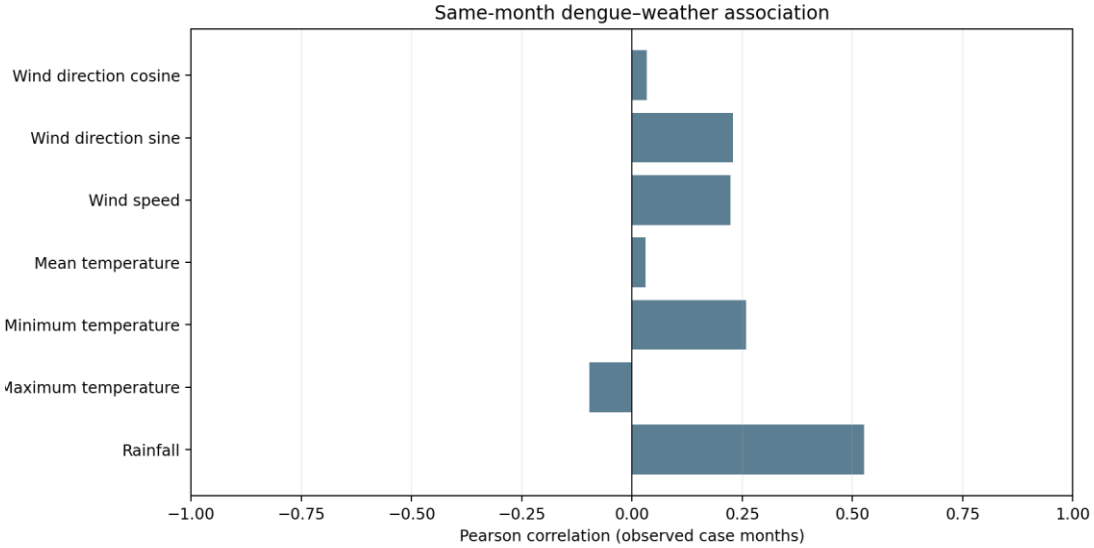


CDEWS Device Evolution

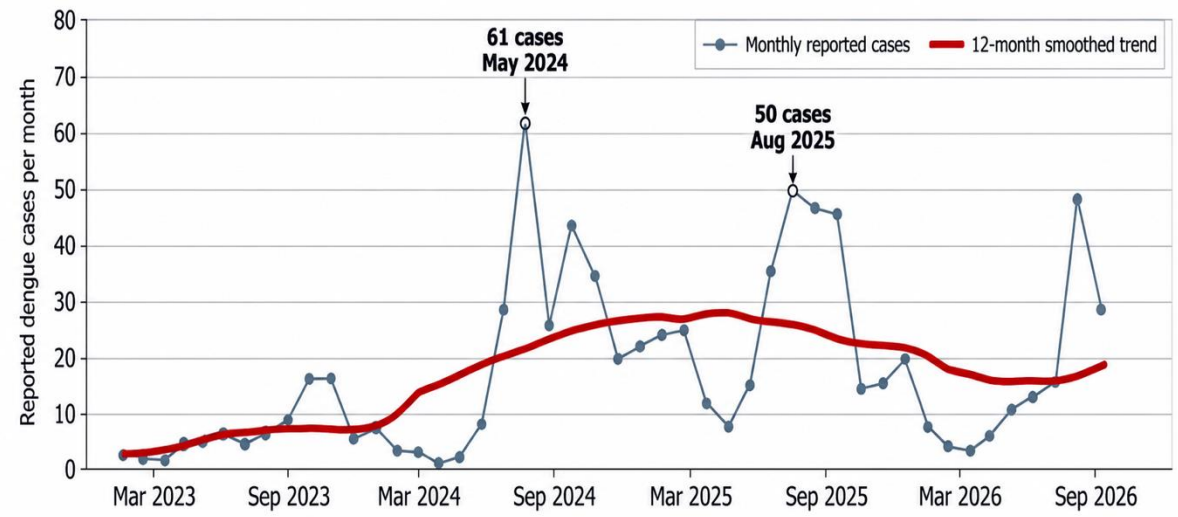
Project Title: Transforming Community Dengue Early Warning System (C-DEWS) Using Multimodal Federated Learning for Dengue Hotspot Prediction and Risk Assessment



Actual vs. Poisson Forecasts with Dengue, Weather, and OL Index



Weather- Dengue Associations in Cauayan City



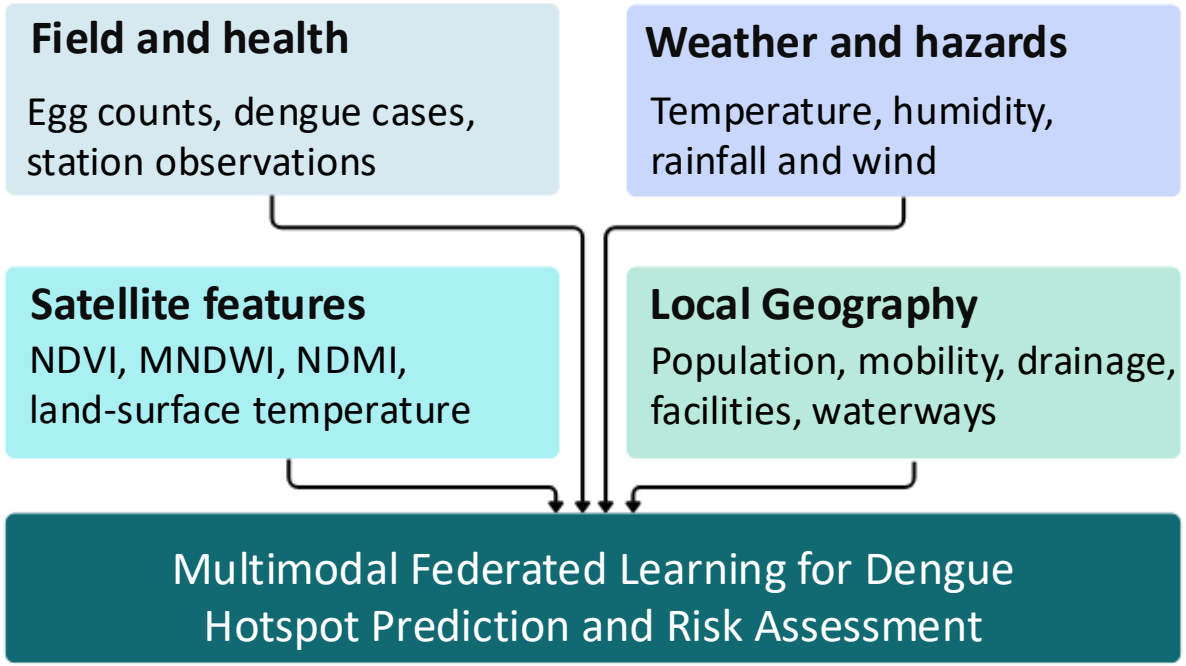
Dengue Cases in Cauayan City, Isabela. (2023-2026)

Repeated peaks motivate a one-month-ahead forecasting study.

Algorithm	Poisson	Negative Binomial	SARIMAX
MAE	6.269	6.882	6.205
RMSE	8.278	9.422	7.316

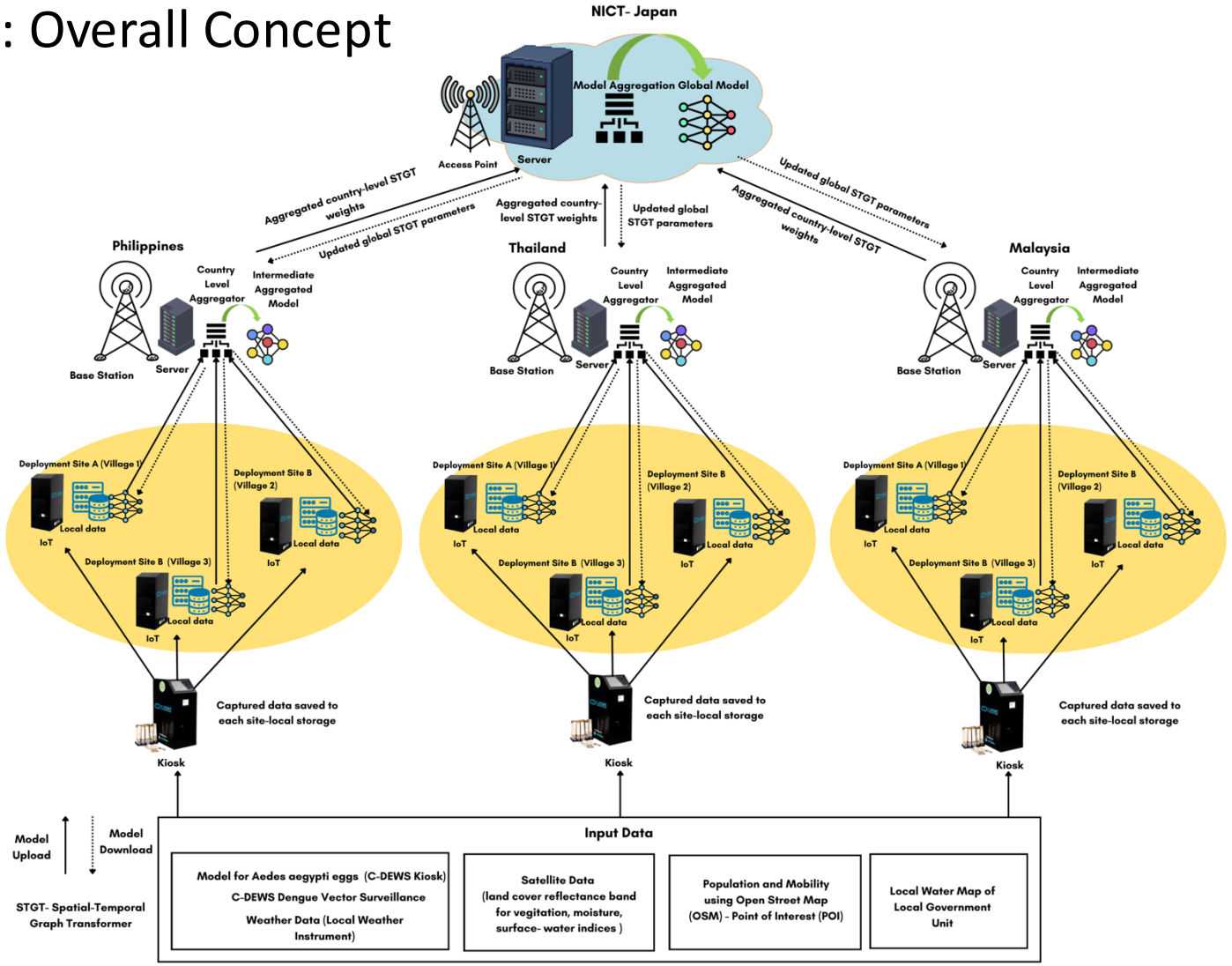
Comparative Forecasting Performance of Prediction Models

Targets:



- Develop and evaluate a Privacy-Preserving Federated C-DEWS Model for dengue hotspot prediction using a shared STGT model
- Integrate MM-sensing using weather, satellite data, and C-DEWS Kiosk for community conditions associated with dengue eggs and dengue cases
- Model spatial-temporal patterns and potential dengue risk propagation across communities.
- Apply Explainable AI and Neuro-Symbolic AI to support targeted public health decisions.

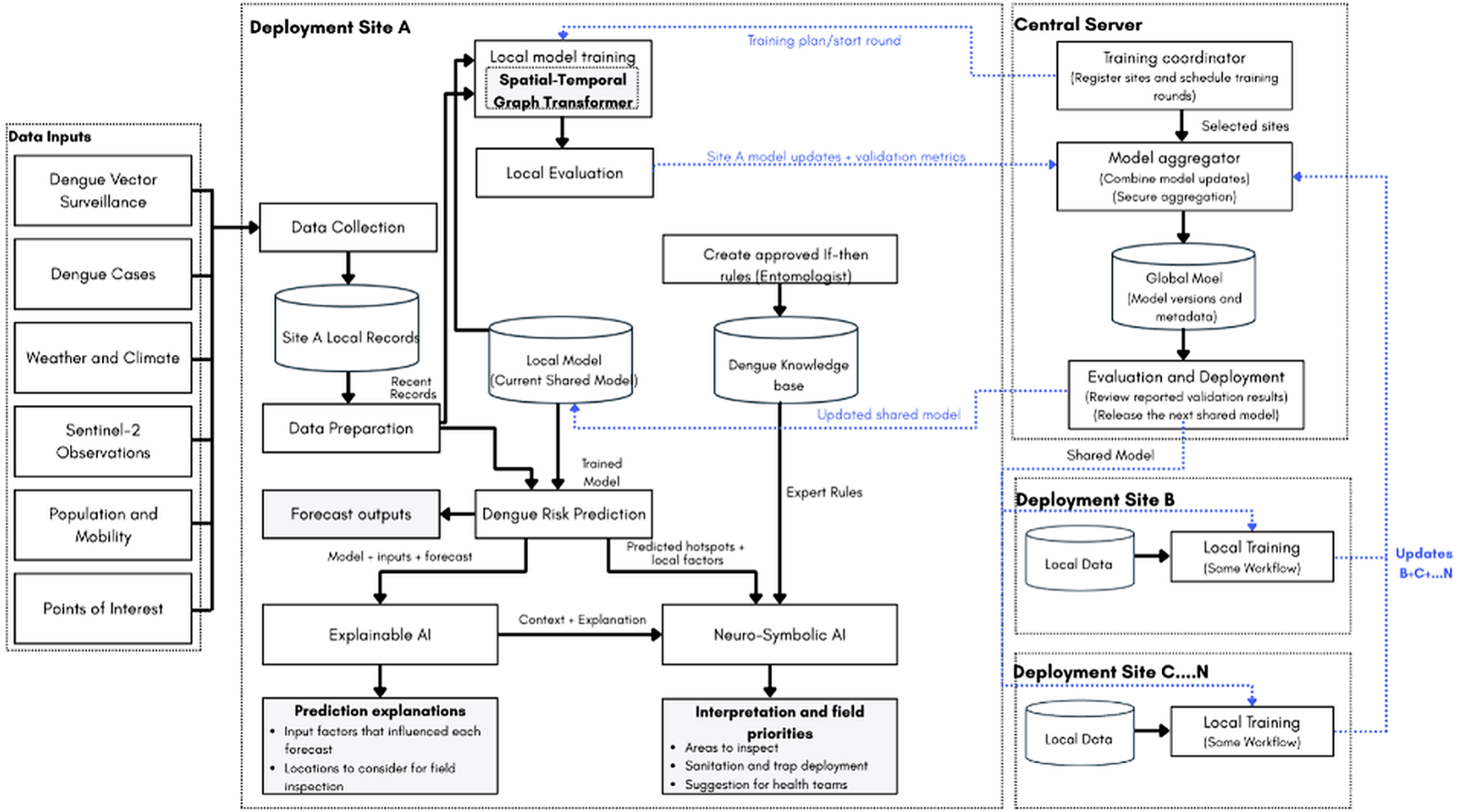
Proposed Method: Overall Concept



Hierarchical Federated-learning architecture

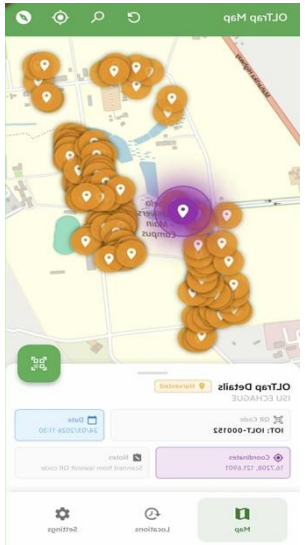
A proposed network that learns across connected sites and observation periods

Proposed Method: Pilot Deployment and Implementation



Multimodal C-DEWS workflow for dengue risk prediction

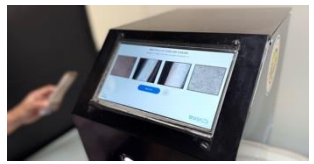




Geo Tagging





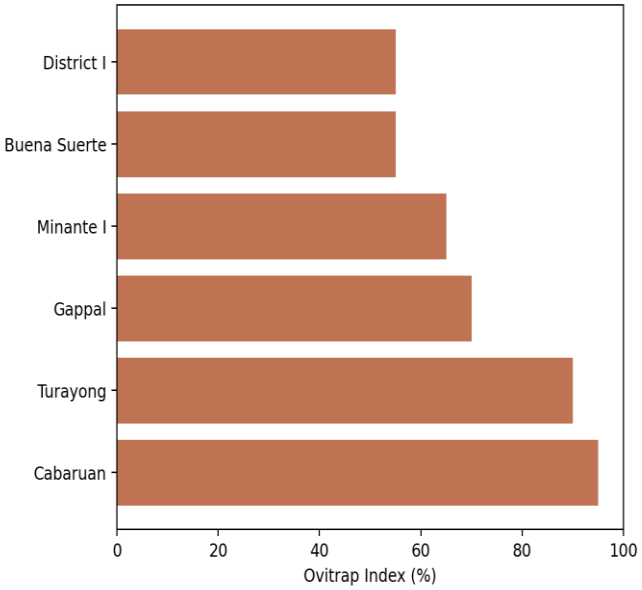


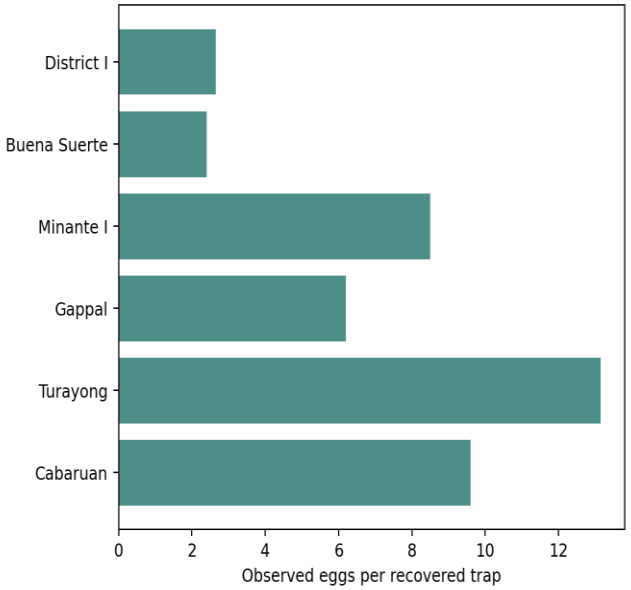
Paddle reading using kiosk

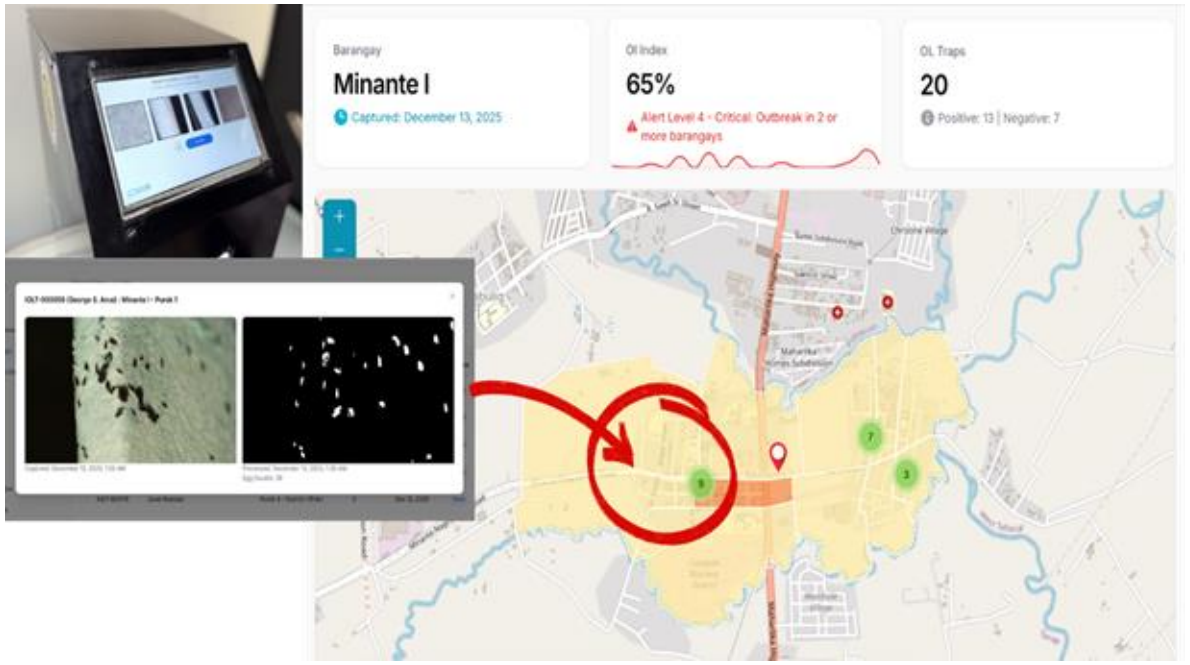


IoT-enabled ovitrap

Impact: Scientific and Technological Impact







- Identified variations in Ovitrap Index and mosquito egg density across six barangays in Cauayan City.
- Ovitrap surveillance revealed substantial spatial variation, supporting localized mosquito monitoring and more targeted dengue prevention planning.















Impact: Societal



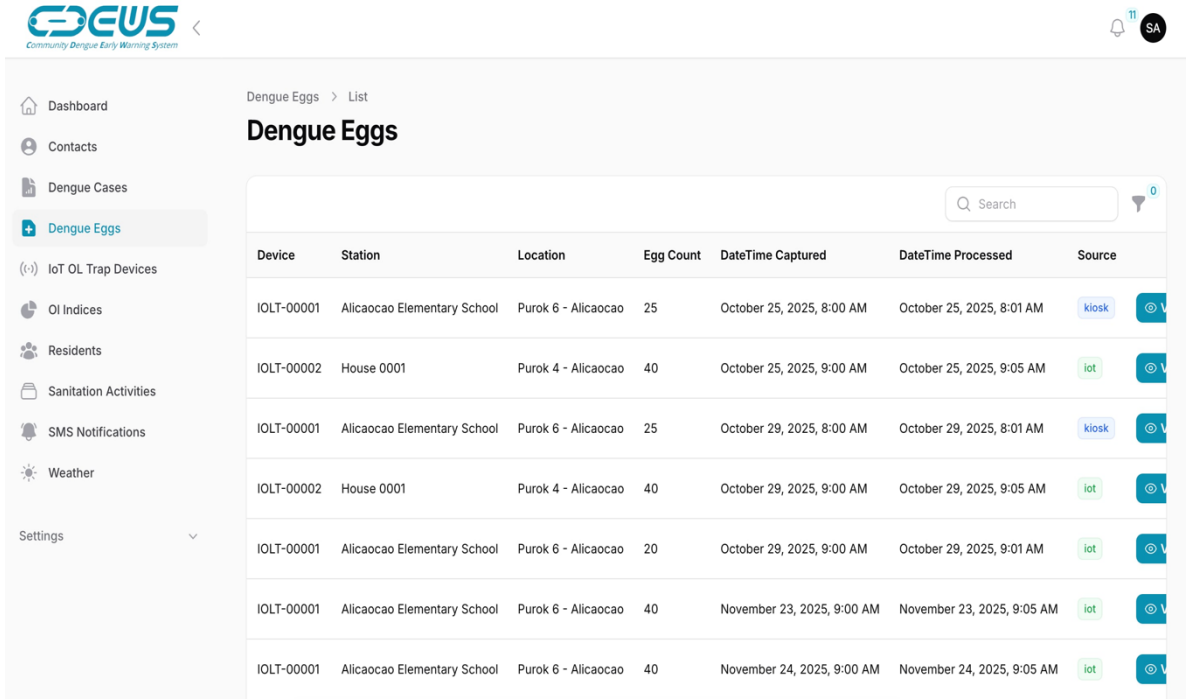


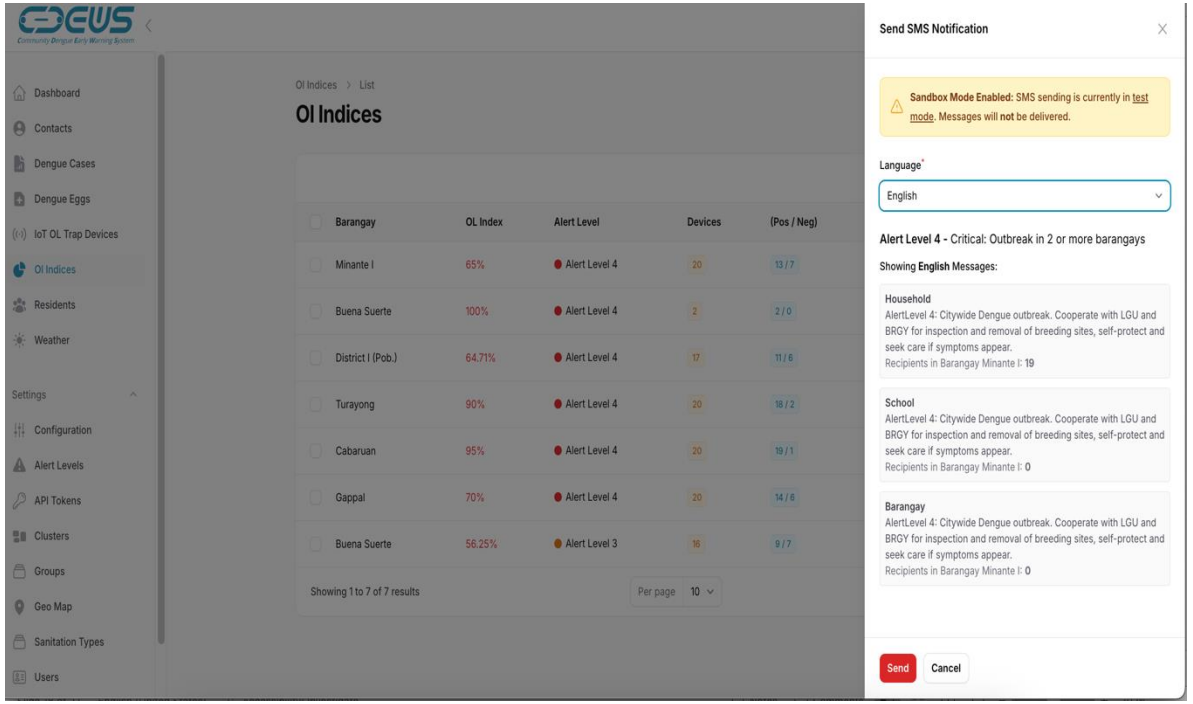
- ✓ Identification of communities where dengue risk may increase.
- ✓ Support for prioritizing mosquito surveillance, vector control, and preventive interventions.
- ✓ Expanded use of C-DEWS kiosks and IoT monitoring to improve access to local surveillance information.
- ✓ Strengthening LGU and community health workers' ability to interpret risk assessments and support prevention planning.

Impact: Collaborative

ACADEMIC AND RESEARCH INSTITUTIONS	GOVERNMENT AGENCIES AND TECHNICAL PARTNERS	COMMUNITY PARTNERS
Isabela State University Lead research and local integration	**LGU's** Provide policy support and coordinate dengue prevention and response activities.	**BARANGAY OFFICIALS/ BARANGAY HEALTH WORKERS** Coordinates community participation
KMITL Robotics, AI and sensor engineering	**DICT** Provide network connectivity support	**HOUSEHOLDS** Participate in OL Trap deployment, monitoring, and dengue prevention activities.
USM Cloud Architecture	**DOST** Coordinating body for scientific and technological research	**SCHOOLS** Participate in OL Trap deployment, monitoring, and dengue prevention activities.
TOKYO INTERNATIONAL UNIVERSITY Cybersecurity and privacy	**NICT** External technical collaborator	**MUNICIPAL HEALTH OFFICE AND HOSPITALS** Monitor and coordinate targeted health interventions

Output



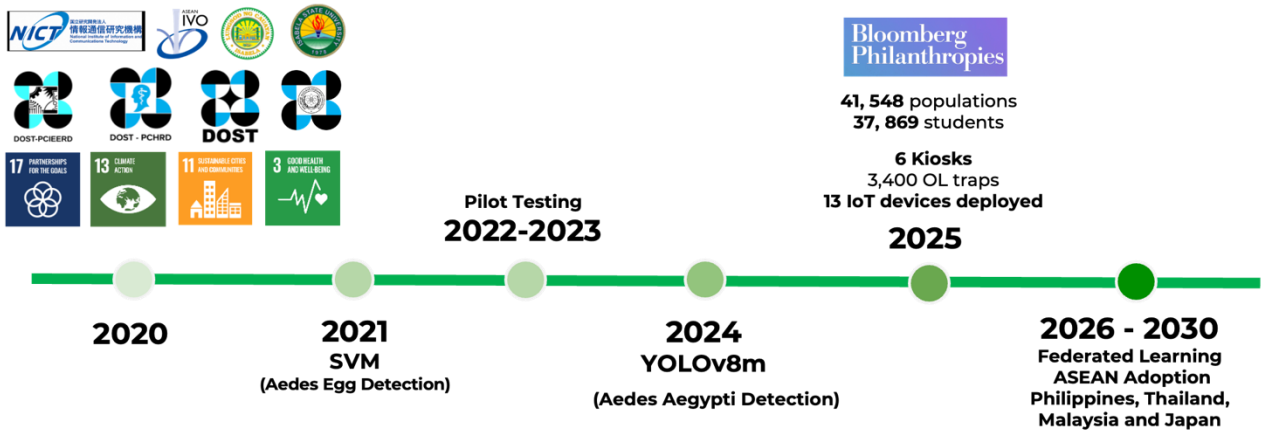


The developed C-DEWS platform integrates mosquito egg data collected through IoT devices and kiosks, displays barangay-level ovitrap indices and alert classifications, and provides an SMS notification interface to support timely dengue surveillance and community awareness.

Outcome

LEVEL 1 (Low Risk; OL Index <20%)	Continue clean-up and remove stagnant water in containers, trash, and plants. If you have high fever, visit the nearest health center. Stay safe.
LEVEL 2 (Moderate Risk: OL Index 20–40%)	Moderate risk in your barangay. Continue search & destroy activities and ensure that everyone uses mosquito repellant, especially the kids.
LEVEL 3 (High Risk: Outbreak in 1 Barangay)	Outbreak in your area. Check home and yard for mosquito breeding sites. Remove stagnant water, use repellent, and visit the health center if fever occurs.
Level 4 (Critical: Outbreak in 2 or more barangays)	Citywide Dengue outbreak. Cooperate with LGU and BRGY for inspection and removal of breeding sites, self-protect and seek care if symptoms appear.

Local Government Unit Customized
OL-Index Alert Level System



- Reduce prevention costs and unnecessary resource use.
- Prioritize high-risk barangays based on the OL Index.
- Implement targeted dengue interventions based on alert levels.
- Encourage regular clean-ups, mosquito protection, and early consultation.
- Reduce mosquito breeding sites and potential dengue exposure.

Societal Outcome Target

Conclusion:

- Community-supported deployment of C-DEWS kiosks and IoT ovitraps, combined with automated egg detection, dengue trend - weather analysis established a foundation for dengue vector surveillance intelligence system for early risk prediction.
- The LGU-developed alert level system strengthened C-DEWS by transforming OL Index results into actionable dengue risk alerts and targeted prevention measures.
- These findings lay the groundwork for a privacy-preserving, explainable multimodal federated learning system integrating C-DEWS kiosks, IoT ovitraps, image analysis, dengue reports, weather, satellite, and spatial data through ASEAN–Japan research collaboration
- Our findings supports strong research collaboration across ASEAN with NICT to continuously innovate the CDEWS using AI-driven dengue vector intelligence for evidence-based interventions, informed resource allocation, and sustainable dengue control