មជ្ឈមណ្ឌលជាតិប្រយុទ្ធនឹងជំងឺគ្រុនចាញ់
ប៉ារ៉ាស៊ីតសាស្ត្រ និងបាណកសាស្ត្រ
National Center For Parasitology Entomology and Malaria Control

Research Grant Round 5 Dissemination Workshop

Development of a climate-based early warning system for dengue fever: a predictive longitudinal study

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Outlines

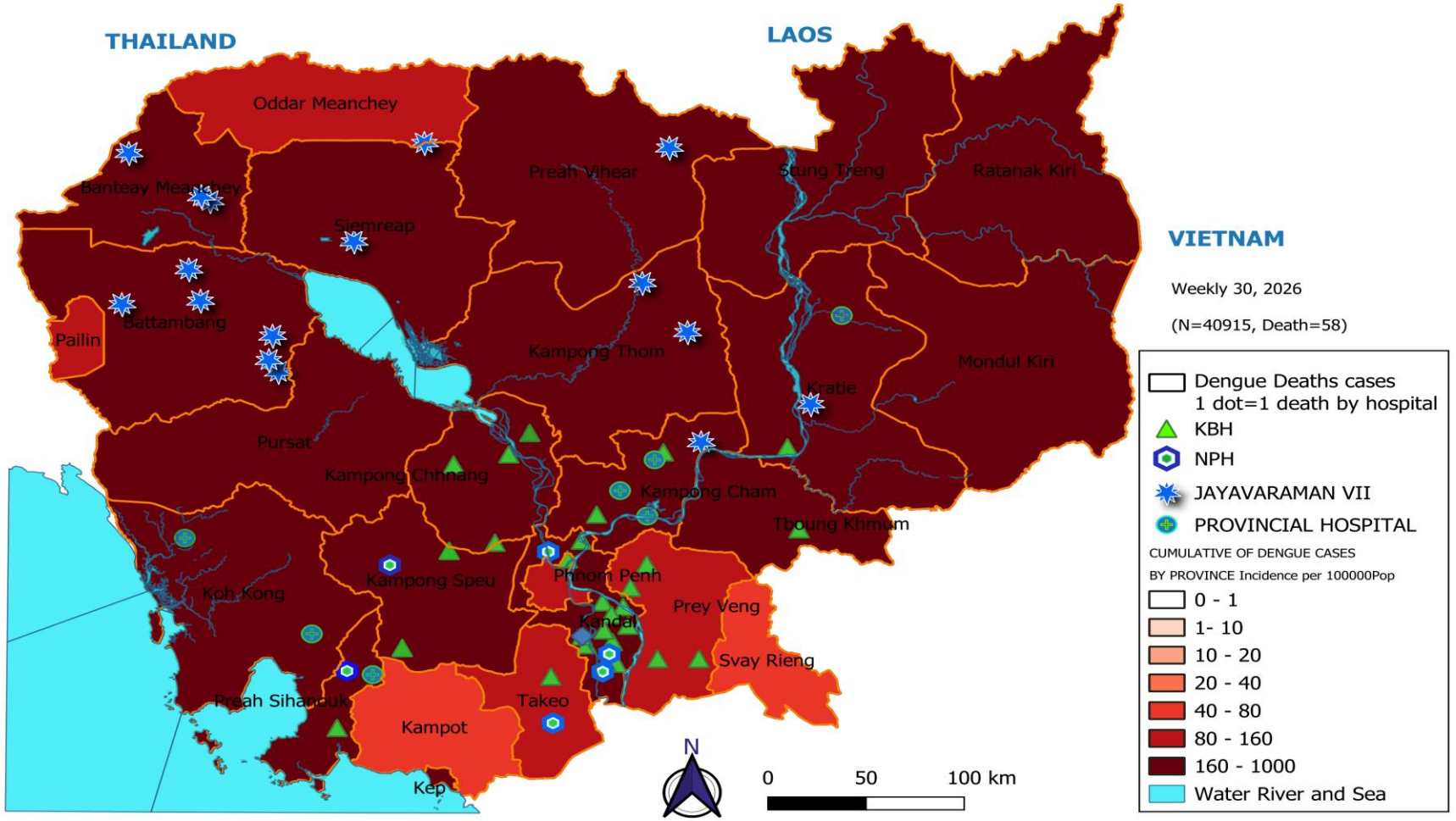
1. Dengue in Cambodia
2. Project Objectives
3. Study Design
4. Research Methodology
5. Research Key Findings
6. Results: Kandal, Siem Reap, Kampong Cham
7. Risk Assessment and Management
8. Key Recommendations
9. Acknowledgements

Dengue in Cambodia

- Dengue occurs throughout the year, but cases often double or triple during the rainy season from May to October.
- Major outbreaks occur approximately every 5 to 6 years and may reach 50,000 cases and around 100 deaths.
- About 13 million people are at risk of dengue nationwide.
- Dengue affects all age groups, but children aged 5 to 15 years account for approximately 70% of the disease burden.
- On average, Cambodia reports about 20,000 dengue cases and 50 deaths each year.
- This is equivalent to about 2.3 new cases every hour and nearly one death each week. These numbers may increase substantially during outbreak years.
- Dengue transmission has expanded geographically and is now reported widely, including in remote provinces.
- Provinces with high population density and large informal settlements face greater risk because of poor sanitation, household water storage, and favorable mosquito-breeding conditions.

Dengue in Cambodia

As of week 30, the National Dengue Program Surveillance System reported 40,915 cases, including 58 dengue deaths, compared to last year, during the same period, there were only 24,397 cases and 40 deaths.



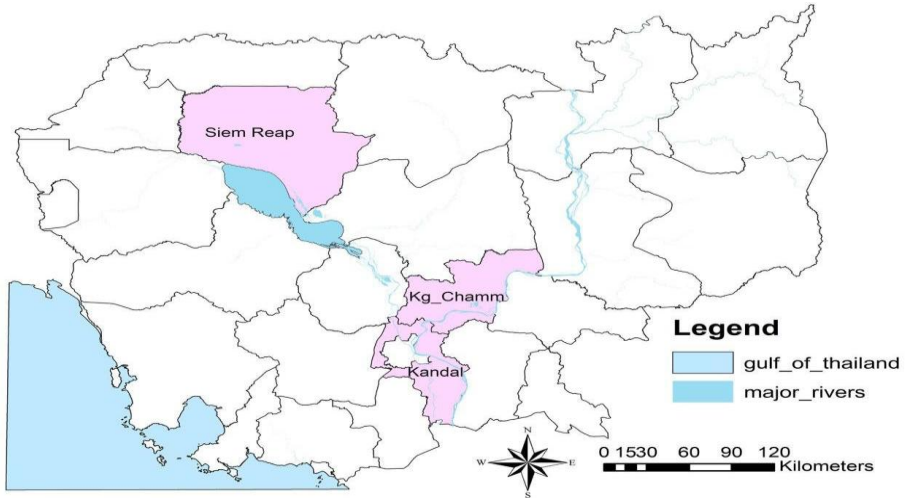
Development of a climate-based early warning system for dengue fever: a predictive longitudinal study

Project Objectives

To develop a real-time predictive model using daily climate data (temperature, humidity, rainfall) to forecast dengue outbreaks.

To create an interactive dashboard that integrates dengue incidence and climate data for improved monitoring.

To evaluate data accuracy by comparing mobile weather data with Ministry data for spatial and temporal consistency.



There are several criteria for this site selection:

- These provinces have the highest incidence of dengue fever among the provinces in Cambodia
- These provinces had a high total number of dengue deaths according to CNM report in 2019
- These provinces had complex geographic characteristics.

Study Design

- The study observes data over time, using both past climate records and current weather measurements.
- We will compare the central climate data with local weather data to see how they relate to dengue cases.
- The main goal is to find out if the local weather data helps predict dengue outbreaks better.

Research Methodology

- Study site:
  - Kandal, Siem Reap, and Kampong Cham
  - Sites were chosen for high dengue incidence and complex environments
- Study period: from September to December 2025.
- Data Collection tools:
  - Daily weather was recorded using mobile devices at selected sites.

Research Methodology

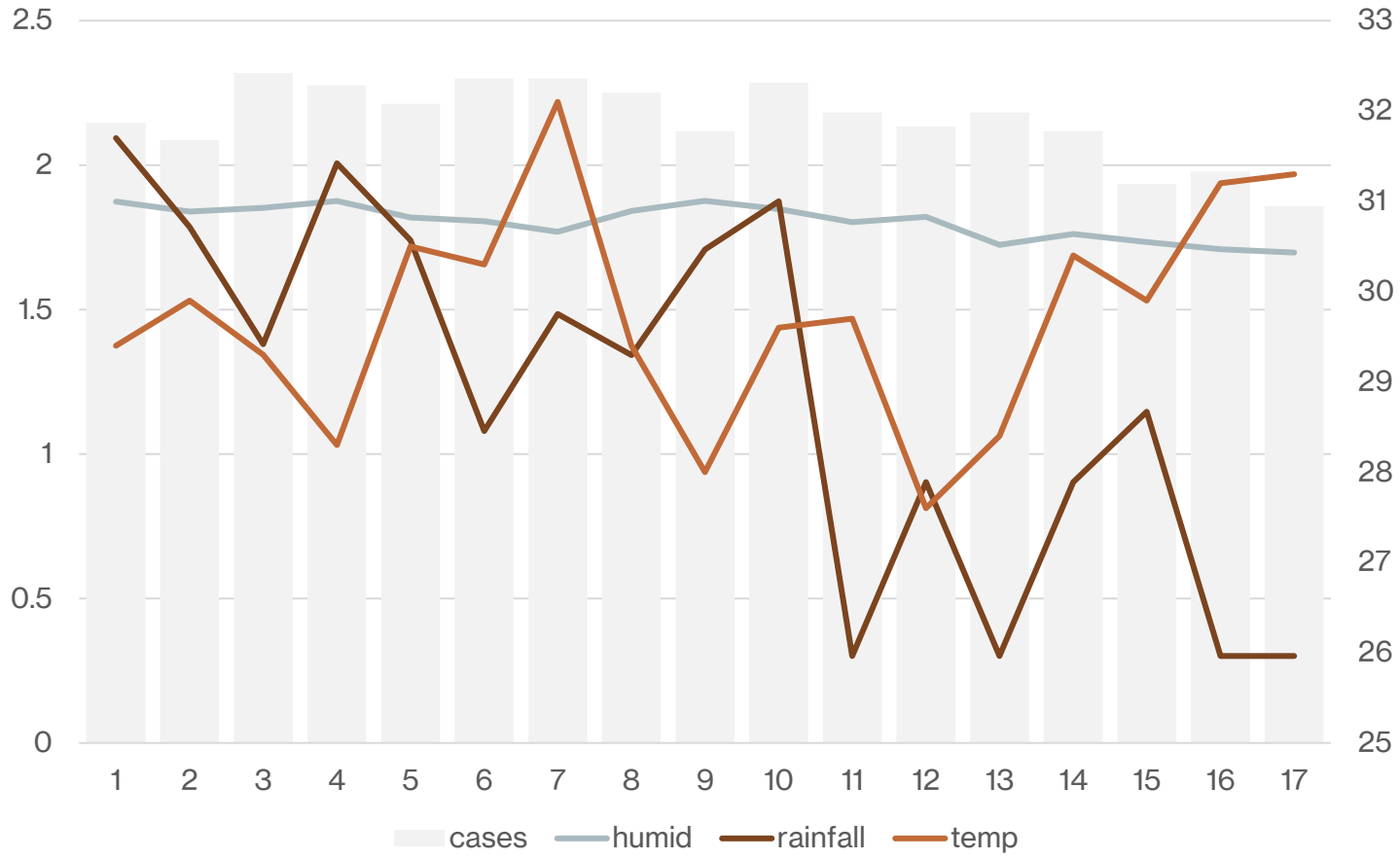
- Data
  - Weekly dengue case counts were obtained from the **National Dengue Control Program surveillance system
  - Daily temperature, humidity, and rainfall data were collected from **local weather devices and centralized meteorological stations.
  - Data analysis with Stata version 17 and Excel for plotting the dengue burden vs. climate data
- Statistical Methods:
  - Dengue case counts showed over-dispersion, with variance greater than the mean.
  - Negative binomial regression was therefore used instead of Poisson regression.
  - Separate univariate and multivariable models were developed for each province.
  - Climate variables were assessed using time lags of 0–5 weeks.
- The lag period reflected the delay from climatic change to mosquito development, dengue transmission, illness, and case reporting.

Research Key Finding

- Climatic drivers of dengue transmission differed across provinces.
- In Kandal, the higher temperature was associated with increased dengue incidence approximately three weeks later.
- In Kampong Cham, dengue transmission was influenced by both temperature and humidity, with warning periods of one to three weeks.
- In Siem Reap, higher local humidity was associated with increased dengue incidence approximately four weeks later.
- The results show that the climatic predictors and warning periods are not uniform across Cambodia.
- Dengue early-warning models should therefore be adapted to the specific climatic patterns of each province rather than applying one model nationwide.

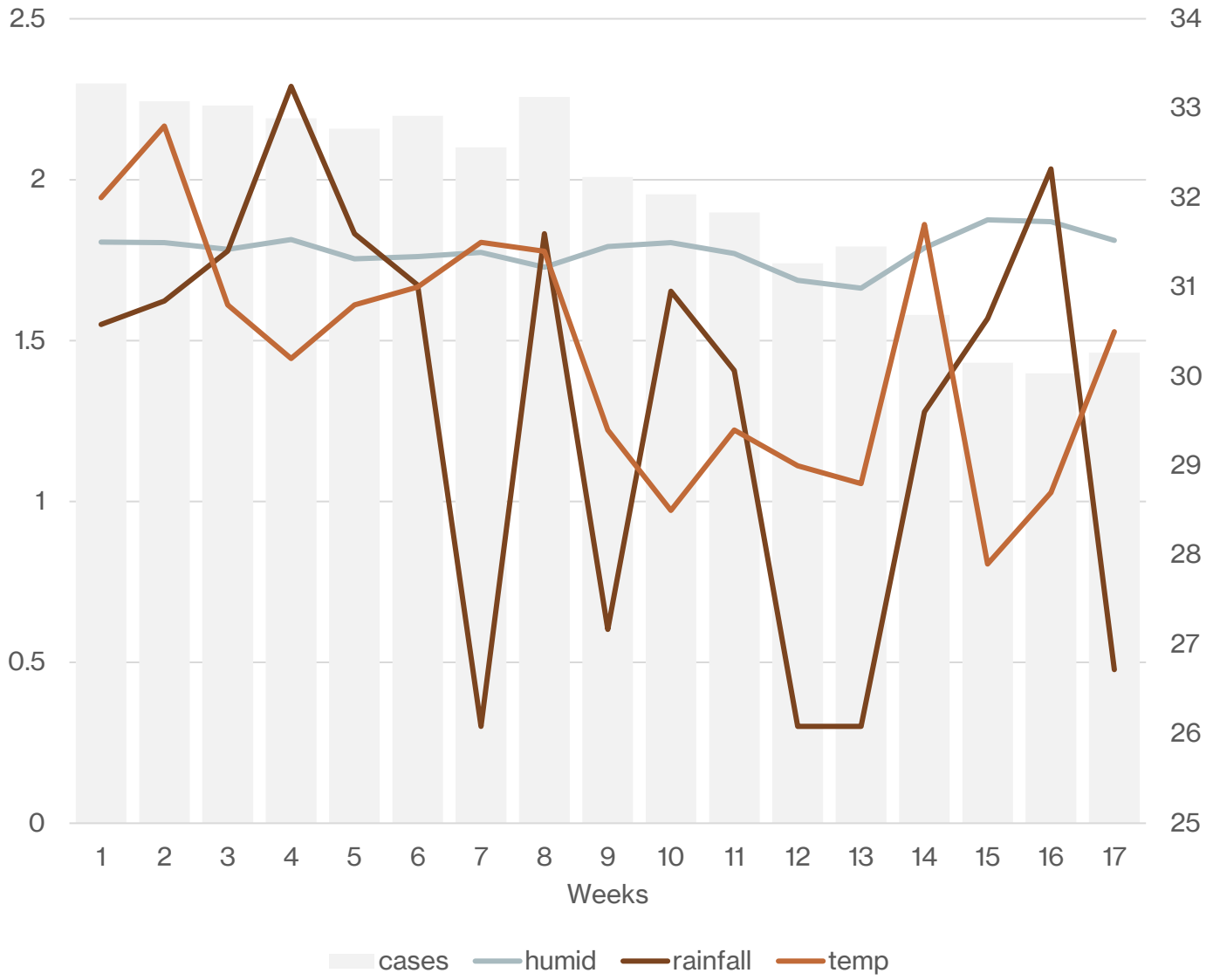
Results: Kandal

Kandal: Temperature was the main predictor of dengue. A **1°C increase** was associated with a **31% increase in dengue incidence three weeks later** (IRR 1.31; 95% CI: 1.19–1.43; $p<0.001$). The Ministry's centralized weather data produced a nearly identical estimate, indicating that it was reliable for Kandal.



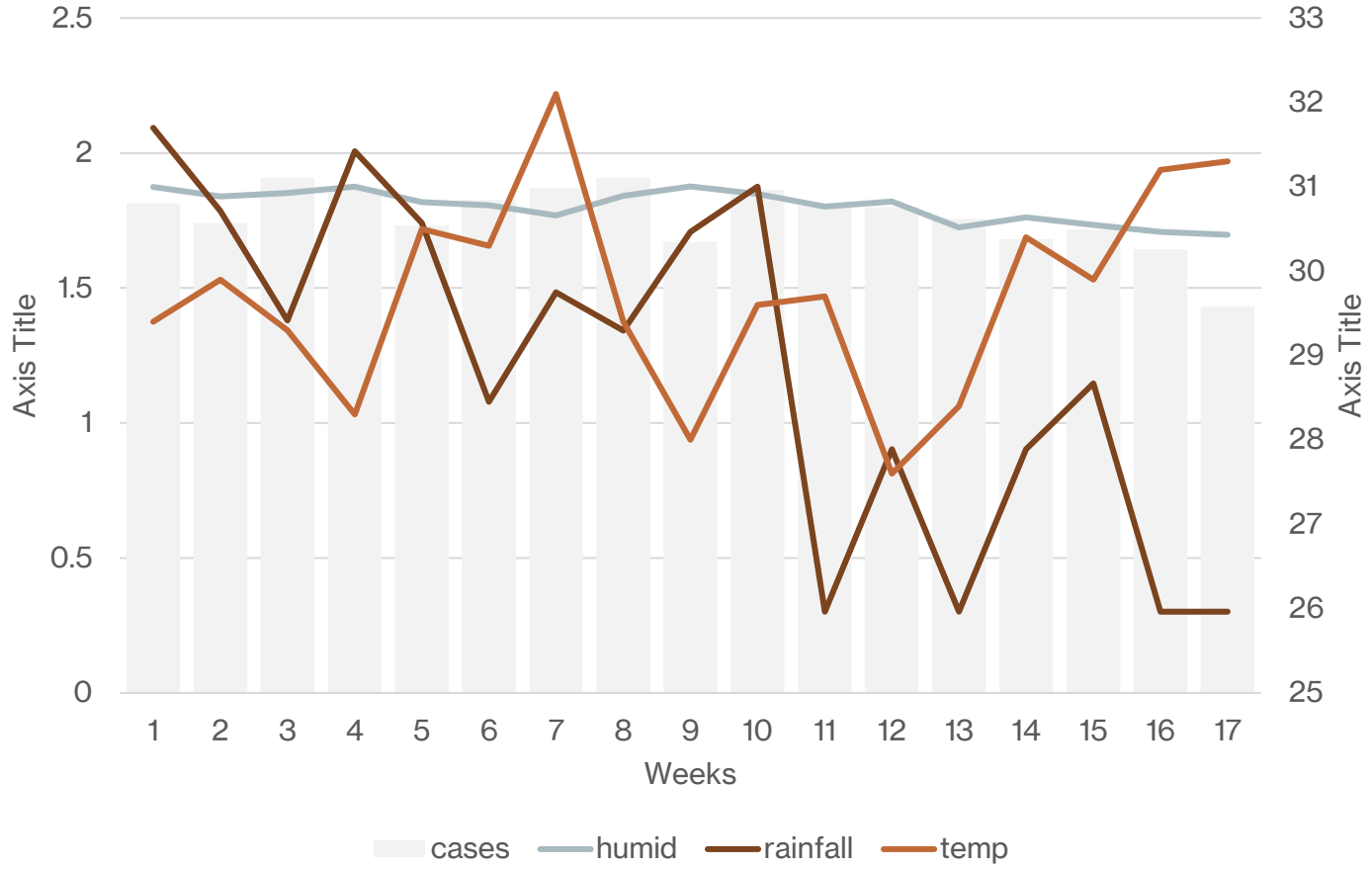
Results: Siem Reap

Siem Reap: Local humidity was the strongest early-warning indicator. Each increase in humidity was associated with a **9% increase in dengue incidence four weeks later** (IRR 1.09; 95% CI: 1.04–1.14; $p<0.001$). The centralized station did not detect this association, showing that regional weather data may miss important urban micro-climate conditions.



Results: Kampong Cham

Kampong Cham: Dengue transmission was influenced by both temperature and humidity. Higher temperature predicted increased dengue incidence after **three weeks** (IRR 1.20; 95% CI: 1.08–1.33; $p<0.001$), while higher humidity predicted increased incidence after **one week** (IRR 1.03; 95% CI: 1.01–1.06; $p=0.023$). Centralized weather data adequately captured the temperature signal.



Results

The climatic drivers and optimal warning periods differed by province. Centralized meteorological data were sufficient for Kandal and Kampong Cham, but local mobile sensors were necessary in Siem Reap. These findings support a hybrid, location-specific dengue early-warning system rather than one national prediction model.

Risk Assessment and Management

Limited access to reliable climate and dengue data may affect the model's accuracy. This can be mitigated by partnering with local agencies and using alternative data sources.

Unpredictable climate events may disrupt data collection. Contingency plans and flexible models will be implemented to adapt to unexpected environmental changes.

Key Recommendations

- Integrate province-specific climate–dengue prediction models into national climate adaptation and dengue preparedness planning.

- Continue community-managed weather monitoring, with strong participation of women to support reliable data collection.

- Further research with one full year to compare the local device and the MOREM local data.

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Thank you ☺