FloodGuard:

AI-driven Flood Prediction and Alert System for Flood-Prone Regions in ASEAN

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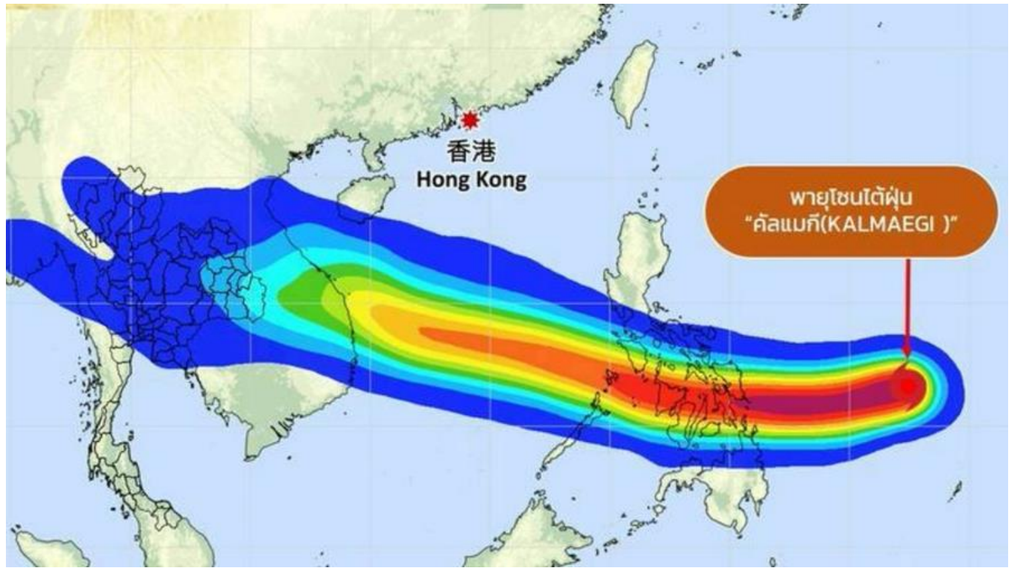
Background :

“Floods are Transboundary by Nature.”



KALMAEGI: 7-9 November 2025

Frequent and severe flooding:

- Southeast Asia faces recurring flash floods causing widespread human, agricultural, and economic losses.

“The hotter the ocean,
the more powerful the storm.”

Chiang Mai, Thailand

Outdated monitoring systems:

- Rely on manual observation and simple alerts
- Too slow and inaccurate to prevent large-scale damage

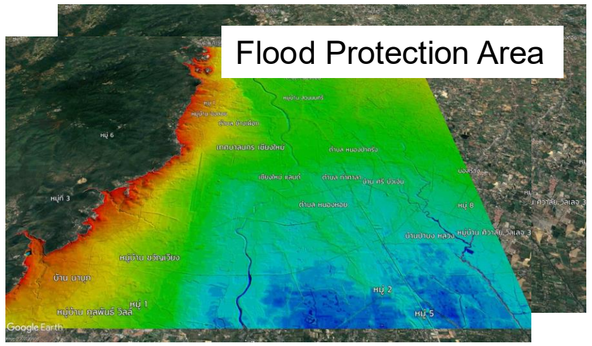
Methodology (1) :

WP1: System Architecture & IoT Integration

- **Design** an end-to-end architecture connecting distributed IoT sensors
- **NICT's NerveNet**, ensuring continuous data flow even during disasters.

WP2: Data Processing Pipeline

- **Synchronization** of heterogeneous data sources:
- Rainfall data, river water levels, weather forecasts, IoT sensors, and historical flood records.
  - Thai Meteorological Department (TMD)
  - Hydro-Informatics Institute (HII)
  - ASEAN Specialized Meteorological Centre (ASMC)
  - NOAA Climate Data Store / GFS



WP3: AI Model Development:

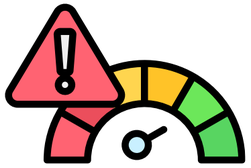
- Recognize temporal and spatial patterns -> Flood prediction and Risk assessment in tropical regions.
- Random Forest, XGBoost, and LSTM
- Transformer Encoder: (many stations → regional-scale flood prediction)
- Hybrid flood nowcasting: rainfall map + station time series → CNN + LSTM

Methodology (2) :

WP4: Field Deployment & Validation:

- **Integrated system** in multiple **ASEAN flood-prone areas** to validate model performance with live data and refine system reliability.
- Transformer Encoder Model: Combine all per-country features
  - [Philippines] → [Vietnam] → [Cambodia] → [Laos] → [Thailand] → [Myanmar]
  - Learning spatial-temporal dependencies by multi-head attention
  - **Transformer Encoder:** Feed Forward + Residual + LayerNorm

"To learn the spatiotemporal relationships across countries,
for example, **rainfall in Vietnam** two days ago may affect **river levels in Laos** today."



WP5: Multi-channel Alert Dissemination:

- Implement an adaptive alert platform that communicates **risk levels (low to emergency)**

WP6: Capacity Building & Knowledge Transfer:

- Training, workshops, and joint research activities to ***enhance local expertise***,
- Open data sharing

Data:

- Thai Meteorological Department (TMD)
  https://data.tmd.go.th/api/index1.php

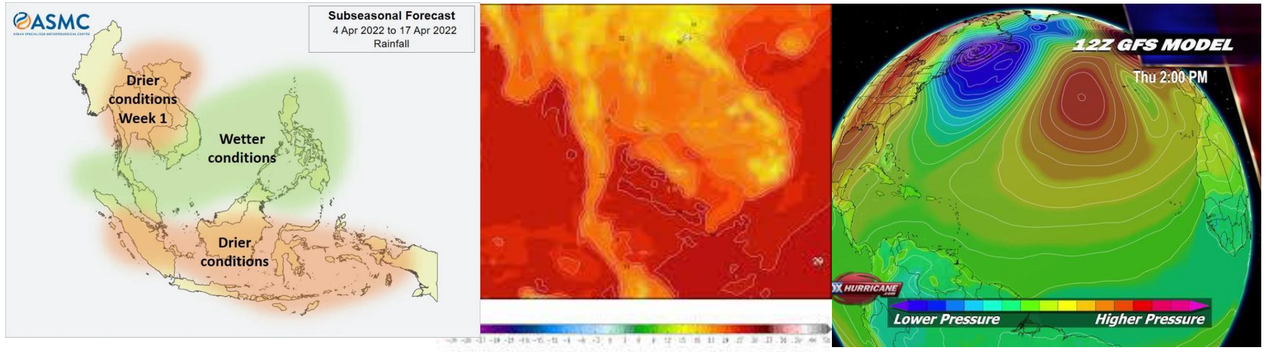
API RainRegions:

RegionName
ProvinceName
Station
StationNameEnglish
Latitude
Longitude
cRainfall Unit="millimeter"

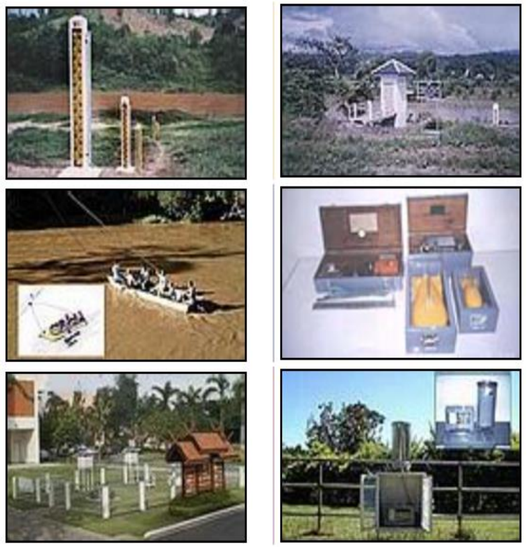
API WeatherForecast7Days:

ProvinceNameEnglish
ForecastDate
MaximumTemperature
MinimumTemperature
WindSpeed
WindSpeed
PercentRainCover

- Hydro-Informatics Institute (HII)
- ASEAN Specialized Meteorological Centre (ASMC)
- NOAA Climate Data Store / GFS



HYDROLOGY AND WATER MANAGEMENT CENTER FOR UPPER NORTHERN REGION



Hydrological Inputs:
Avg Annual **Rainfall**
Max Rainfall Intensity
Catchment Area

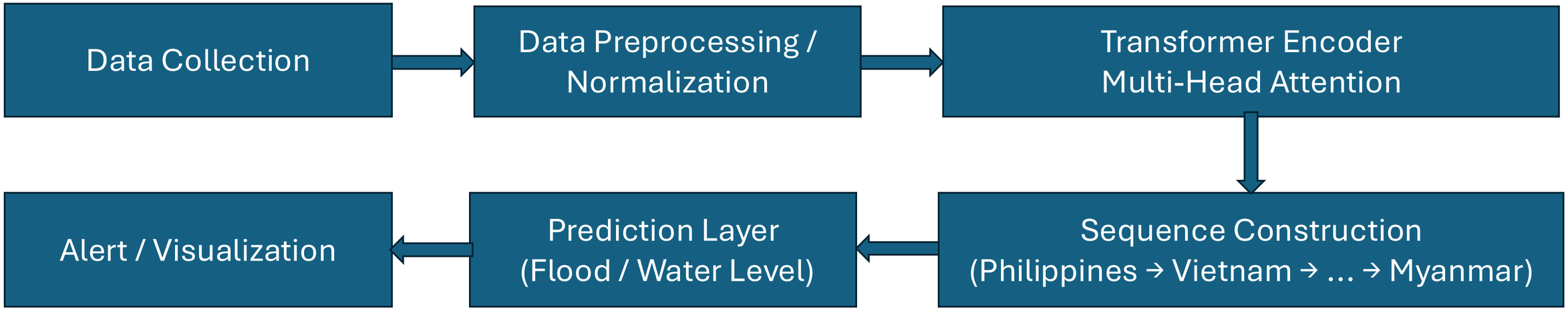
Statistical / Historical Data:
Year(s) of Bank Overflow
Max and Min Recorded Levels
Discharge Statistics

River and Flow Characteristics:
Channel Capacity
River Length / slope
Max Flow Velocity
Water level
Previous Day Rain

Purposed Method :

Purposed Method : **Integrated system** in multiple **ASEAN flood-prone areas**

- Transformer Encoder Model: Combine all per-country features such as
  - [Philippines] → [Vietnam] → [Cambodia] → [Laos] → [Thailand] → [Myanmar]

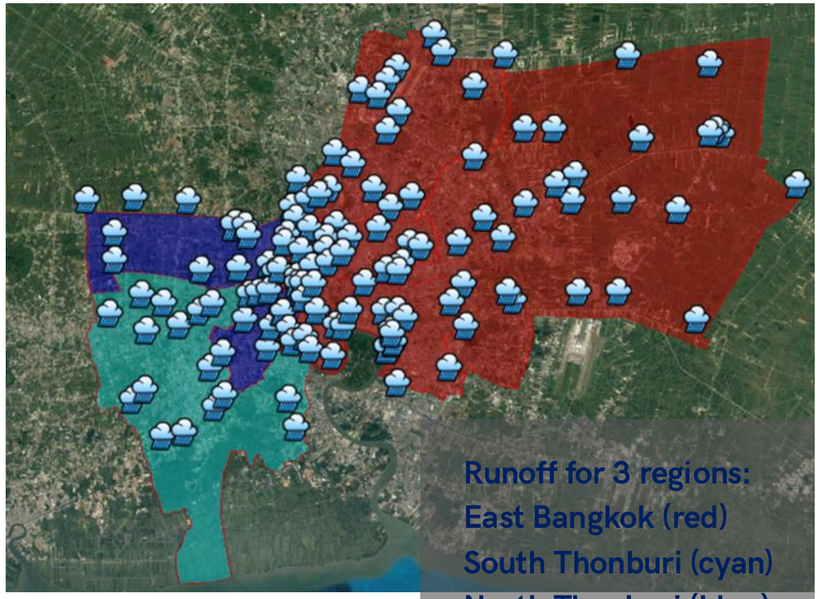


Expected Output:

- Cross-border Rainfall Propagation
- Hydrological Influence Map via Attention Weights → data-driven spatial dependency map
- Temporal Lag Insights: Lead time of early warning system

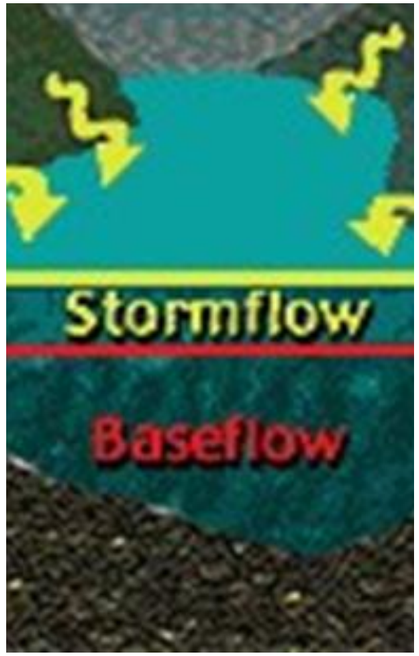
Previous Work (1) :

Development of an Empirical-Based Rainfall-Runoff Model Using Observation and Forecast Precipitation: A Case Study in Bangkok, Thailand

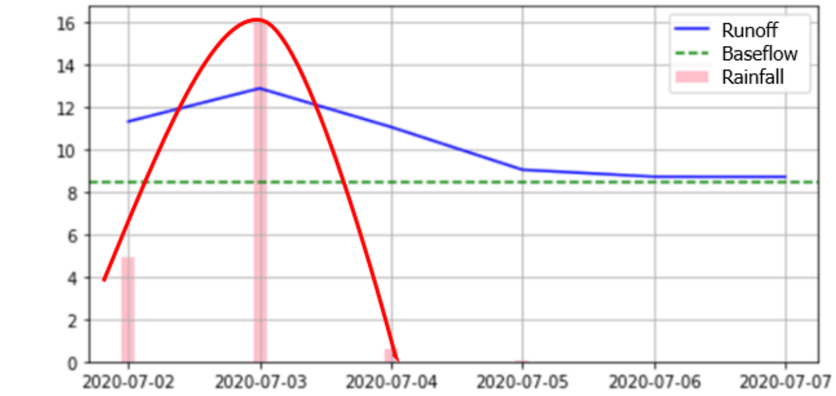


128 rain stations in Bangkok

Runoff for 3 regions:
East Bangkok (red)
South Thonburi (cyan)
North Thonburi (blue)



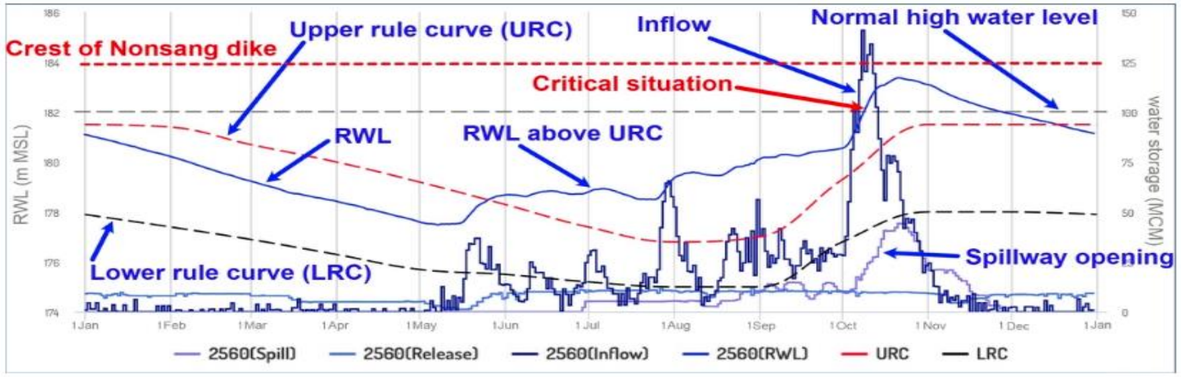
$$Runoff = \text{Baseflow} + \text{Storm flow}$$



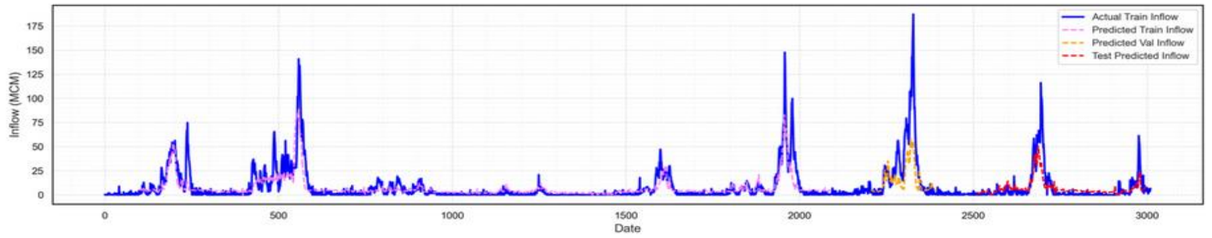
Predict flood, Control Water Salinity

Previous work (2) and Ongoing Research

RNN-Driven Inflow Forecasting for Dam Safety Monitoring Using Local Meteorological Data



Water situation at Ubol Ratana dam in 2017.



Inflow prediction compared to actual inflow in 2nd iteration.

Dam safety systems: the issue regarding *inflow prediction* for dam safety management.

FireSpot & Smoke Detection in Chiang Mai

Database Construction:

Ongoing Research

Visual IoT, Satellite Imaging, and Data Fusion

Joint Research with the University of Bristol 'AI-Driven Visual IoT and Data Fusion for Early Detection of PM2.5 from Biomass Burning in Chiang Mai

Impact :

Scientific and Technological:

- Advances AI applications in hydrology and disaster management, integrating IoT, satellite data, and deep learning for real-time flood forecasting.
- Provides a scalable, open-source model adaptable to multiple ASEAN environments

Societal:

- Enhance community safety and disaster preparedness, reducing loss of life and property in flood-prone areas.

Collaborative:

- Fosters cross-border cooperation among ASEAN institutions and partners

Broader and Long-term:

- Contributes to ASEAN's digital and climate resilience goals under the SDGs framework.

Output/outcome :

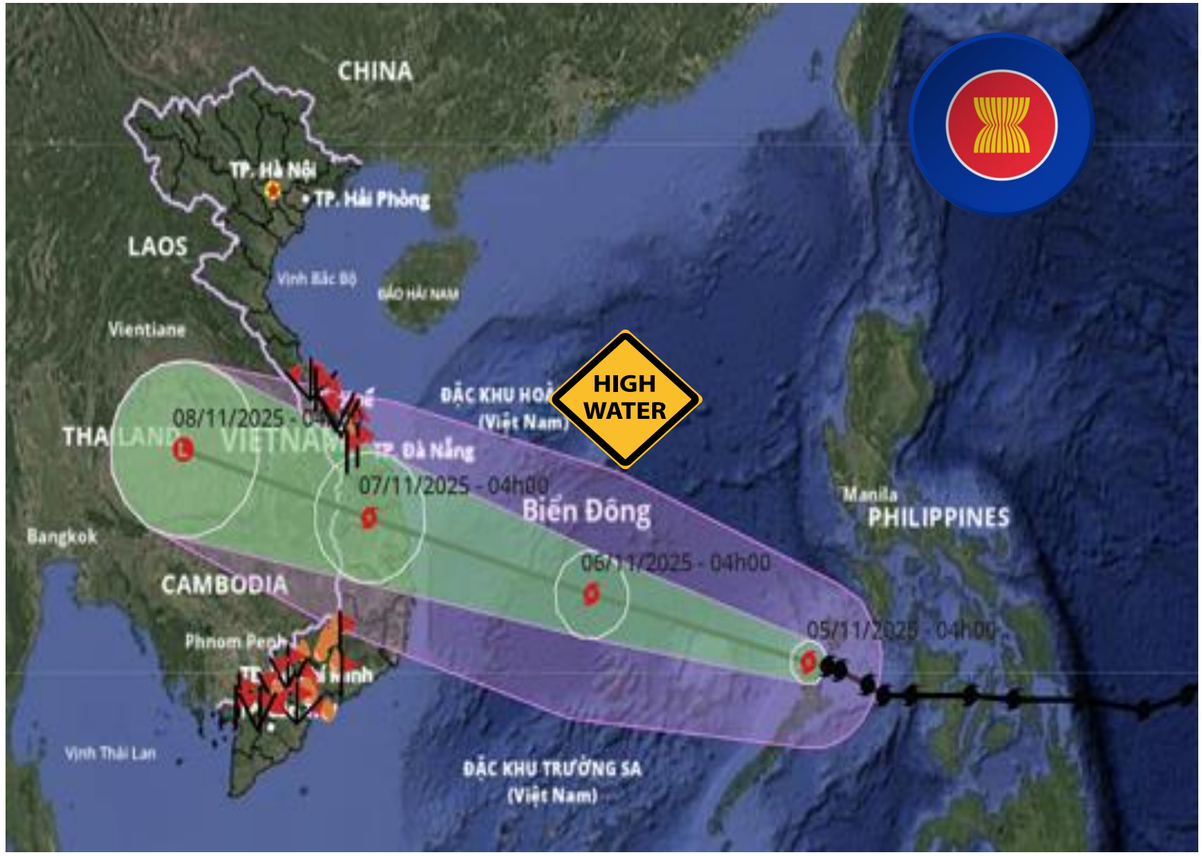
OUTPUT

- AI-driven Flood Prediction Model in ASEAN
- Open-access Datasets and Open-source Codes for supporting regional research
- Real Time Alert System providing rapid risk-level communication

OUTCOME

- A replicable model for AI-driven environmental disaster management
- Strengthened ASEAN capacity in AI and resilient communication technologies
- Reduced loss of life and property through timely early warnings

Conclusion :



Floods are Transboundary by Nature.

↓

Shared Data = Stronger AI Prediction.

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Disaster risk reduction benefits all ASEAN citizens.

Long term:

Multi-Hazard Early Warning and Monitoring Platform

- Integration of Multi-Hazard Data Ecosystem
- ***Floods***, wildfires, PM2.5 air pollution, and mine-related water contamination.

Thank You

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