

Predicting Flood Inundation Using Machine Learning in Developing Countries

Takanobu Kaneko, Natsuki Yoshikawa, Maulana Ibrahim Rau, Hiroya Sato, Yusuke Sato

9th ASIAN REGIONAL CONFERENCE

Irrigation & Drainage

75th IEC MEETING

1-7 Sept 2024 | ICC Sydney



CONFERENCE AND EXHIBITION

2 - 4 September 2024 | ICC Sydney

Niigata University, Niigata, Japan





Increase in rainfall events

The damage of inundation //

Especially delta regions are vulnerable.

In deltas, efforts were done to reduce the damage utilizing the water management facilities





 \bigcirc

L CONFERENCE



Current Study

Operation of water management facilities

- Non-emergency : manual
- Emergency : based on experience
- The number of operators are decreasing
 - \rightarrow Difficult to transfer the techniques

Objective

To develop real-time simulation model for predicting inundation



9th ASIAN REGIONAL CONFERENCE Infordion & Drainage 79th IIC MEETING Infordia I Madray (19) Kitocap



Process-based physical model

Accurately simulate the physical phenomenon



Computational load is large

Machine learning model

Computational load is small



Needs many training data

Machine learning model is suitable for real-time prediction



th ASIAN REGIONAL CONFERENCE getion & Drainage th IEC MEETING MEETING AUSTRALIA CONFERENCE AND EXHIBITION



Flow of Building Model



9th ASIAN REGIONAL CONFERENCE
Information
Structure
CONFERENCE
CON

の の の の まさをテル 新潟大學 NIIGATA UNIVERSITY

Flow of Building Model

Problem

Need many training data

Flood events have long recurrence periods

Complement the data with numerical simulation model





Ith ASIAN REGIONAL CONFERENCE



Numerical Simulation- based Flood Model



Inundation Flow Submodel

Calculates inundation flow between land parcels

Runoff Submodel

Calculates Runoff from Land Parcels

1D Unsteady Flow Submodel

(Yoshikawa et al,2011)

Calculates Drainage Channel Flow



9th ASIAN REGIONAL CONFERENC Infection & Desinage risk IIC MEETING



Numerical Simulation- based Flood Model



Drainage Channel



Need correct and precise data to make accuracy outcome



Path ASIAN REGIONAL CONFERENCE regation & Drainage risk ac Meterina - Constant (100 page) (100 page) (100 page)



Data Availability of Developing Countries (In General)

Availability of data



n & Drainage MEETING CONFERENCE AND EXHIBITION



Elevation Data

To obtain grid elevation and cross section of channels

Remote Sensing- based Digital Terrain Model (RS-DTM)

- → Developed by co-researcher Julzarika Atriyon from The National Research and Innovation Agency of Indonesia (BRIN)
- Possible to be adapted to numerical simulation model

(Rau, et al., 2024)





Nth ASIAN REGIONAL CONFERENC rightion & Drainage sch isto Mettinio (1997 2019 - 109 July) (1997 Kito-celo AUSTRALIA CONFERENCE AND EXHIBITION



Rainfall Data

Global Satellite Mapping of precipitation (GSMap)

Possible to get the data anywhere

KOR-CHE

Rainfall data per 10 minutes



9th ASIAN REGIONAL CONFERENCE W/// IRRIGATION CONFERENCE AND EXHIBITION



Rainfall of Training Data

Simulated rainfall

→ Monte Carlo methodology from Minagawa et al. (2020)

Rainfall dataset

	100mm	200mm	300mm
Training data	300	300	300
Test data	15	15	15





Pith ASIAN REGIONAL CONFERENCE
rightion & Drainage
rightico Microsoftino
-Tage Asia
-Tag

Long Short-Term Memory (LSTM) Model



Research Area

Xuan Thuy watershed in Vietnam



Stil ASIAN REGIONAL CONFEI Infation & Dainage 78th IIC MEETING



Accuracy of the numerical simulation model





Result of numerical simulation

Hazard map



WINIEATION AUSTRALIA CONFERENCE AND EXHIBITION



Accuracy of the numerical simulation model





Flood extent was generally well-replicated



th ASIAN REGIONAL CONFERENCE



Accuracy of the numerical simulation model



Result of numerical simulation

showed very precise outcomes aligning well with the observed data.



REGIONAL CONFERENC



Process of Learning

We fine-tuned several key parameters to obtain the most optimum parameters.

Parameter

Batch size	10	
LSTM unit	1,000	
Learning rate	0.0001	
Epoch	500	
Dataset	900	

KOD-CHE











Numerical simulation

LSTM model



9th ASIAN REGIONAL CONFERENCE Irrigation & Drainage 29th IEC MIETINO 1-1 Mar ANNI I DO Indrey III KID-COD



Conclusion

- The model can be applied even in regions lacking high topographic and temporal-resolution rainfall data by using RS-DTM and GSMap
- Possible to build the machine learning model by using numerical simulation model as training data
- LSTM model is more time efficient than the conventional physical model approach

Numerical simulation

Around **30 min**



💶 Xuan Thuy, Viet Nam

Flood Map Inland Flood Model

Maximum Flood Depth Map



https://marswm-asia.streamlit.app/

REGIONAL CONFERENCE

