Historical Flood Simulation and Evaluation the performance of Gridded Precipitation Datasets in Prek Thnot River Basin

27th January, Phnom Penh Cambodia

Oudomsatia Huong[1], Sophal Try[2], Ty Sok[1,3,*], Sophea Rom Phy[1], Ratboren CHAN[1,3], Chantha Oeurng[1]

[1] Faculty of Hydrology and Water Resources Engineering, Institute of Technology of Cambodia

[2] Disaster Prevention Research Institute, Kyoto University

[3] Research and Innovation Center, Institute of Technology of Cambodia, Phnom Penh, Cambodia

Contents

Introduction

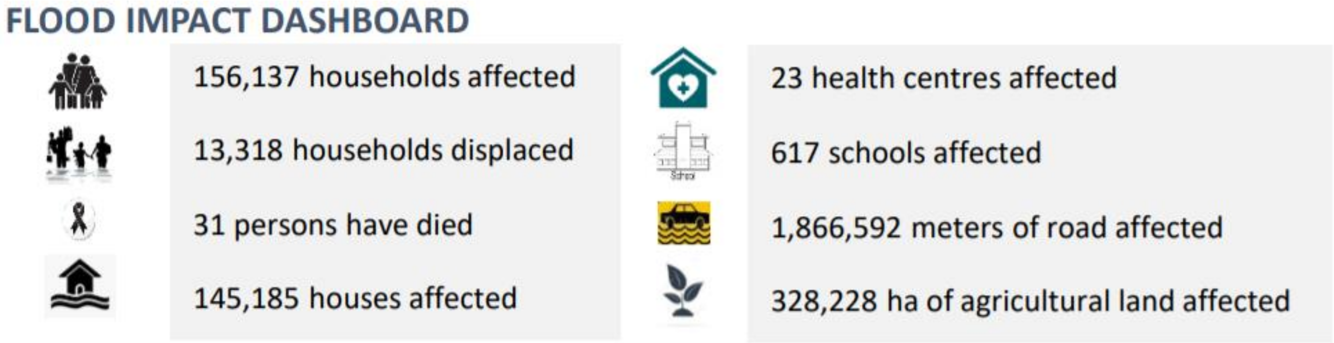
Methodology

Result and Discussion

Conclusion

1. Introduction

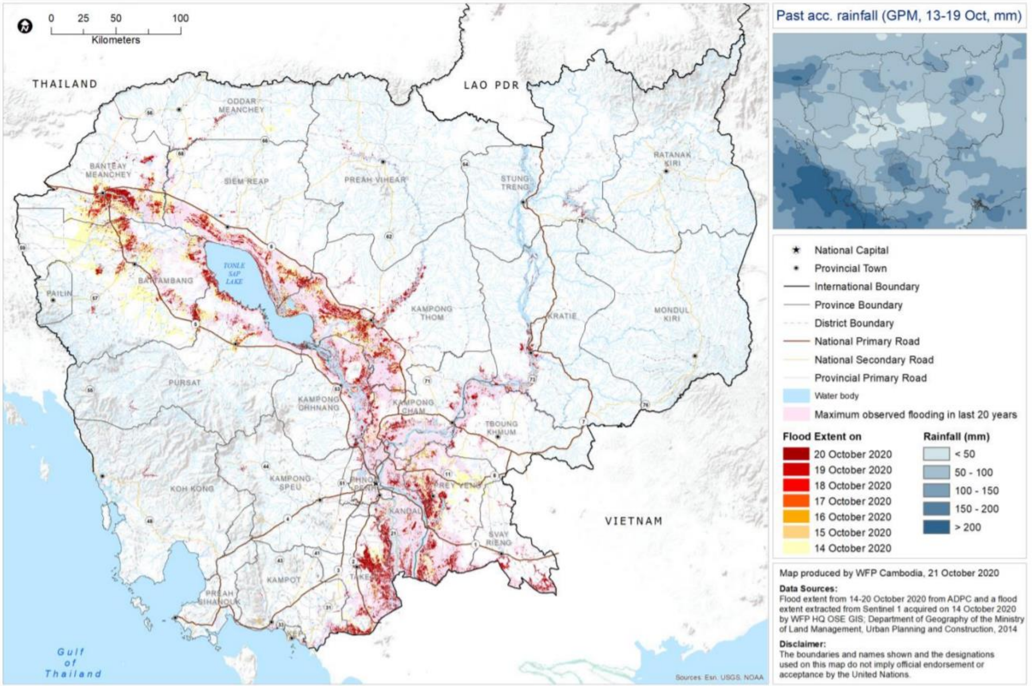
- Flood is the most common natural disaster that usually happens everywhere and difficult to control.
- It happens every year in the Lower Mekong River Basin (LMB), and in Cambodia, that causes huge economic damage, affects people, and destroys large area of agriculture.
- Flood is the most frequent hazard occurring in Cambodia (72%). 11 fatalities occurred and about 67,995 households in 19 provinces were affected by flash floods in 2020.
- Precipitation is one of the most critical climatic parameters, causing annual flooding and influence many factors in the hydrological system.



Since 1 October, -21 October

https://www.humanitarianresponse.info/en/operations/cambodia

SATELLITE-DETECTED WATER (as of 20 October 2020)



1. Introduction (Cont.)

- Flood in Prek Thnot River Basin.
- The basin has become increasingly vulnerable to dangers and calamities (IRD, 2018), particularly droughts and floods.
- As a consequence of the various activities and more rainfall received upstream, flooding can occur downstream at any moment.


From MOWRAM,


www.khmertimeskh.com


From MOWRAM,

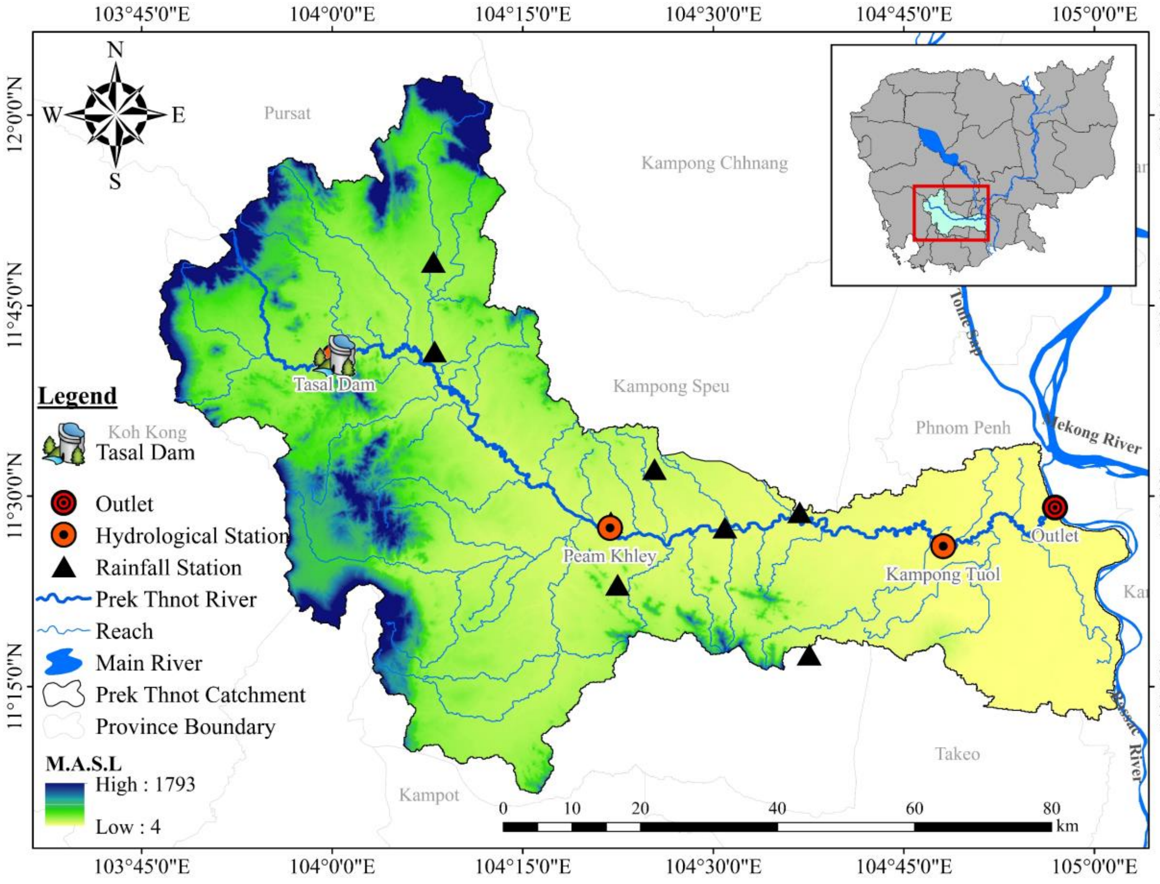
Therefore, this study aims to:

✓ Evaluate the performance of a rainfall-runoff-inundation model in the whole Prek Thnot River Basin for river discharge and flood inundation.

✓ Evaluate the performances of precipitation between five different gridded precipitation datasets and ground rain gauge for future perspective of flood forecasting system.

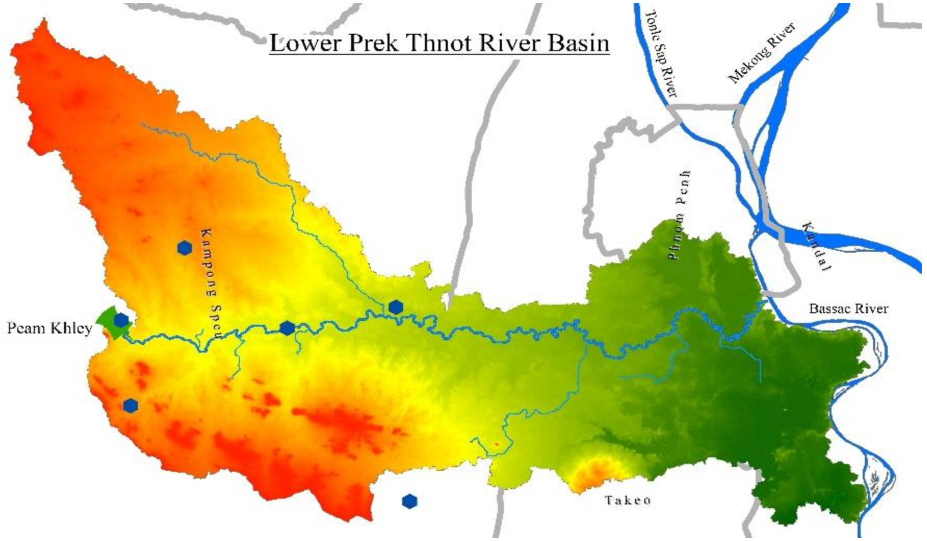
2. Methodology

2.1. Study Area



The Prek Thnot River Basin

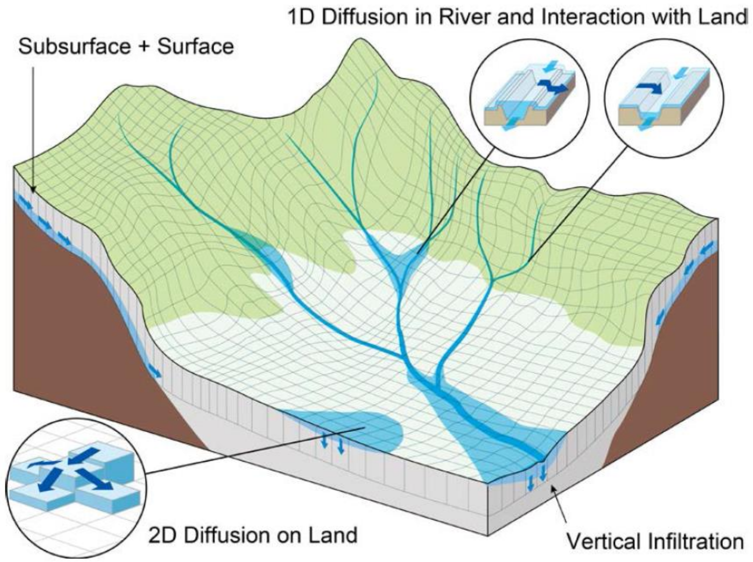
- Area: 6,660 km^2
- Covers: Koh Kong, Kampong Speu, Kampot, Takeo, Kandal, and Phnom Penh
- Elevation: 4 m – 1793 m (M.A.S.L)

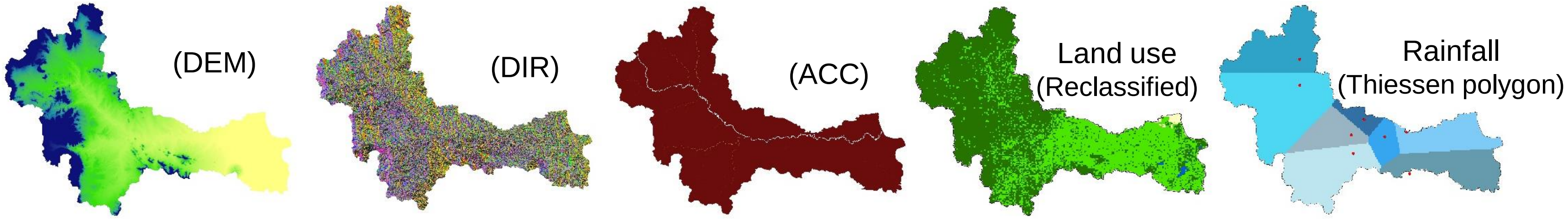


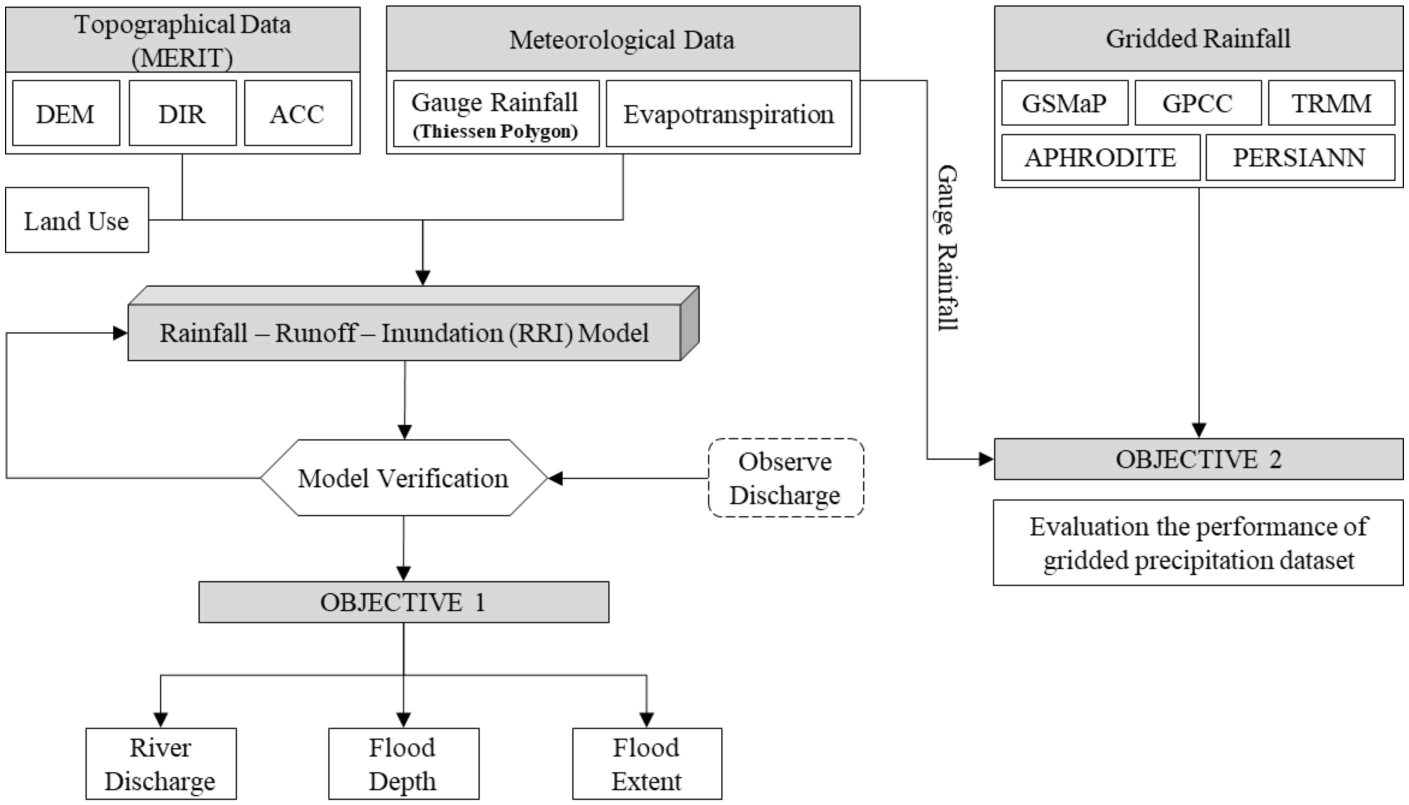
2. Methodology (Cont.)

2.2. Rainfall-Runoff Inundation (RRI) Model Simulation

- The RRI model is a two-dimensional distributed hydrodynamic model that can simulate rainfall, runoff, and inundation all at the same time.
- The model was set up at 540 m at a daily time-step from September to November 2010.







2. Methodology (Cont.)

2.3. Model Performance

The model's performance is evaluated using statistical indicators such as Nash-Sutcliffe efficiency (NSE), Percent bias (PBIAS), Root mean square error observation standard deviation ratio (RSR), and Coefficient of determination (R^2).

Performance rating	NSE	PBIAS (%)	RSR	R^2
Very good	0.75 < NSE ≤ 1.00	|PBIAS| < 10	0.0 ≤ RSR ≤ 0.50	0.70 < R^2 ≤ 1.00
Good	0.65 < NSE ≤ 0.75	10 ≤ |PBIAS| < 15	0.50 < RSR ≤ 0.60	0.60 < R^2 ≤ 0.70
Satisfactory	0.50 < NSE ≤ 0.65	15 ≤ |PBIAS| < 25	0.6 < RSR ≤ 0.7	0.50 < R^2 ≤ 0.60
Unsatisfactory	NSE ≤ 0.50	|PBIAS| ≥ 25	RSR > 0.7	R^2 ≤ 0.50

$$NSE = 1 - \frac{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_i^{sim}\right)^2}{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_{mean}^{obs}\right)^2}$$

$$RSR = \frac{\sqrt{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_i^{sim}\right)^2}}{\sqrt{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_{mean}^{obs}\right)^2}}$$

$$PBIAS = \frac{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_i^{sim}\right)\times 100}{\sum_{i=1}^{n}\left(Q_i^{obs}\right)}$$

$$R^2 = \left[\frac{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_{mean}^{obs}\right)\left(Q_i^{sim} - Q_{mean}^{sim}\right)}{\sqrt{\sum_{i=1}^{n}\left(Q_i^{obs} - Q_{mean}^{obs}\right)^2}\sqrt{\sum_{i=1}^{n}\left(Q_i^{sim} - Q_{mean}^{sim}\right)^2}}\right]^2$$

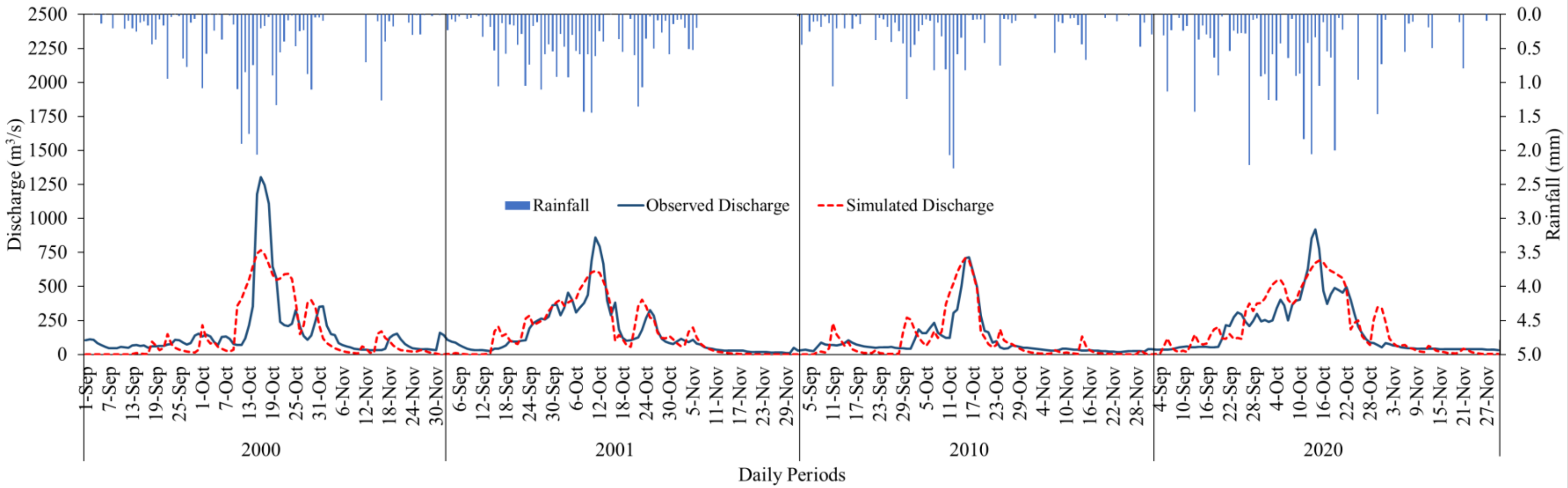
Where: $Q_i^{obs} =$ The i^{th} observed streamflow $Q_i^{sim} =$ The i^{th} simulated streamflow $Q_{mean}^{obs} =$ The mean of observed streamflow $n =$ The total number of measurement

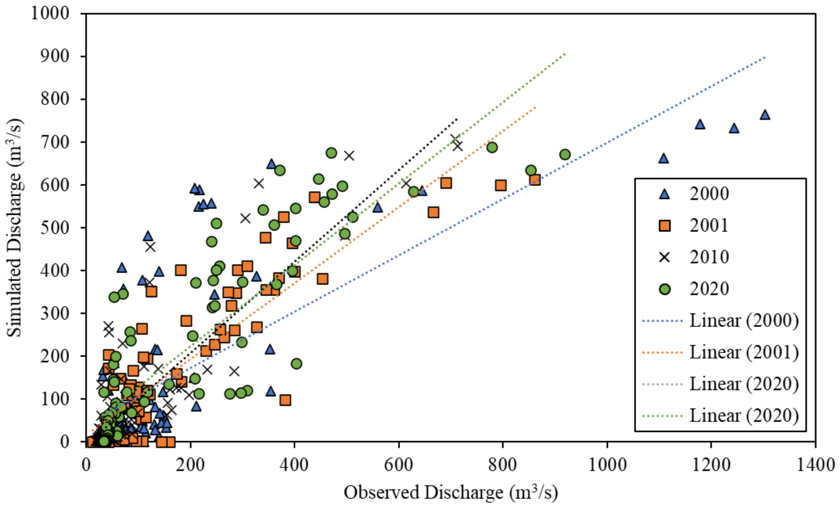
3. Result

3.1. River Discharge

Calibration: 2010 flood event

Validation: 2000, 2001, and 2020 flood events



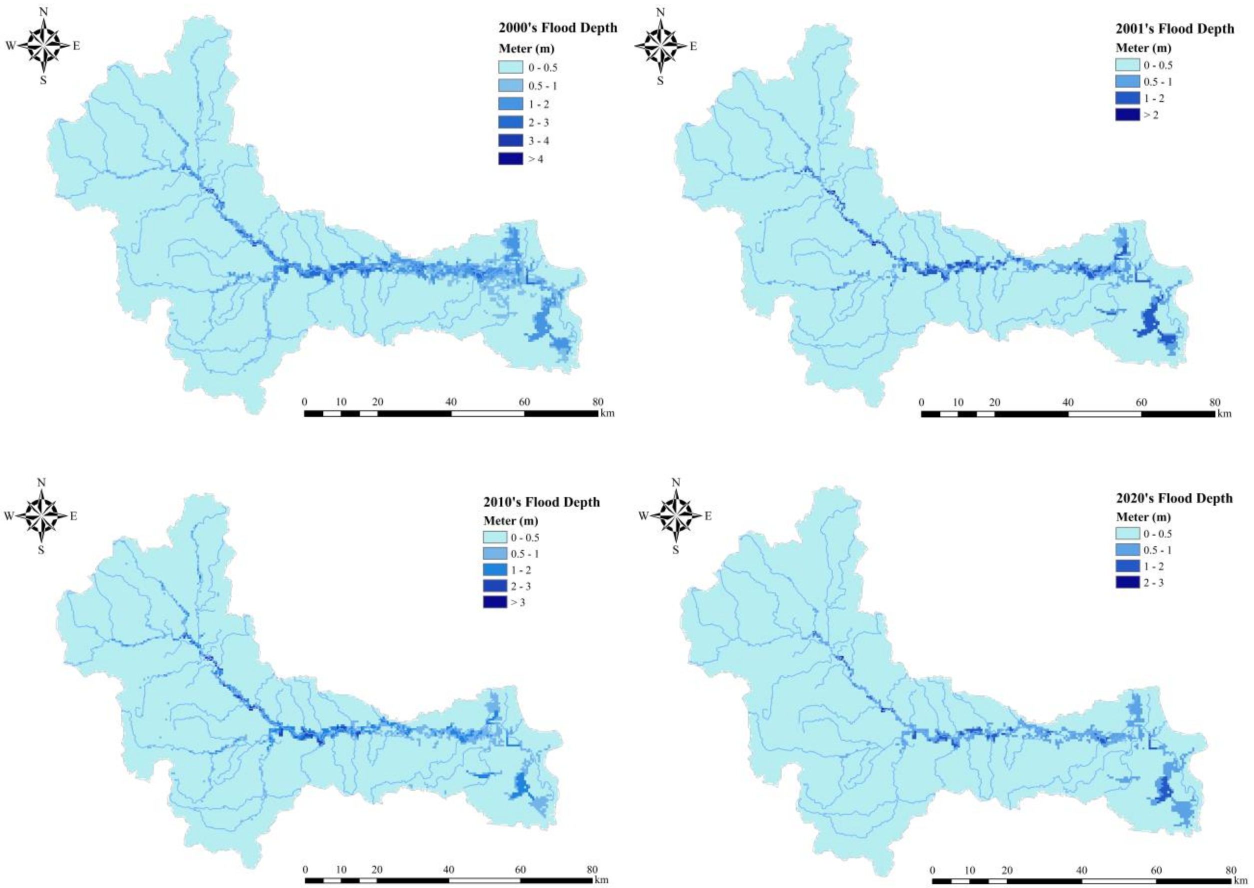


Flood Event / Statistical Indicators	2000	Remark	2001	Remark	2010	Remark	2020	Remark
NSE	0.55	Satisfactory	0.78	Very good	0.64	Good	0.70	Good
PBIAS (%)	8.34	Very good	1.01	Very good	-2.26	Very good	-13.75	Very good
RSR	0.67	Satisfactory	0.47	Very good	0.60	Good	0.55	Good
R^2	0.57	Satisfactory	0.79	Very good	0.76	Very good	0.76	Very good

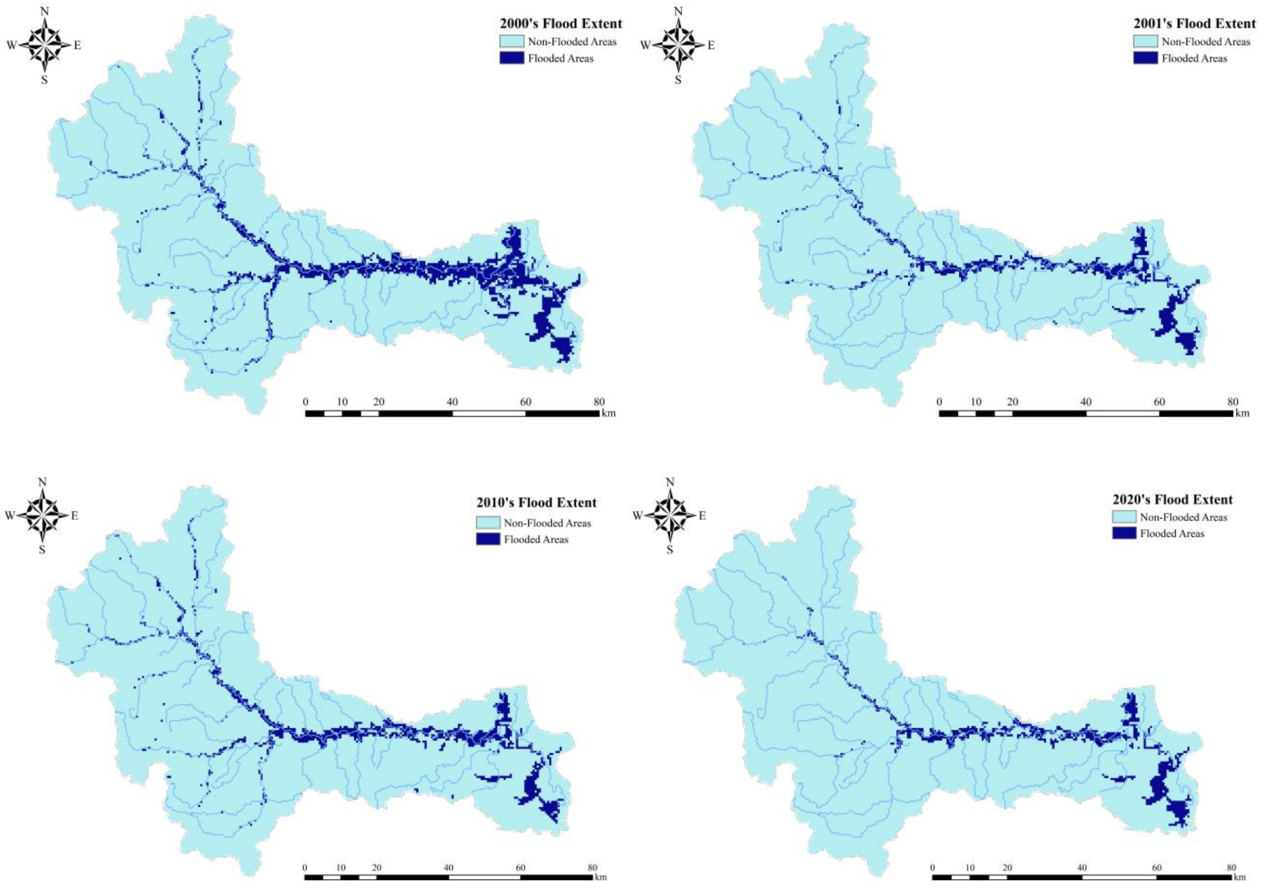
Year	Equation	R^2
2000	y = 0.656x + 42.823	0.568
2001	y = 0.8878x + 16.236	0.7882
2010	y = 1.0677x + 4.5273	0.765
2020	y = 0.9507x + 33.871	0.7599

3. Result (Cont.)

3.2. Flood Inundation



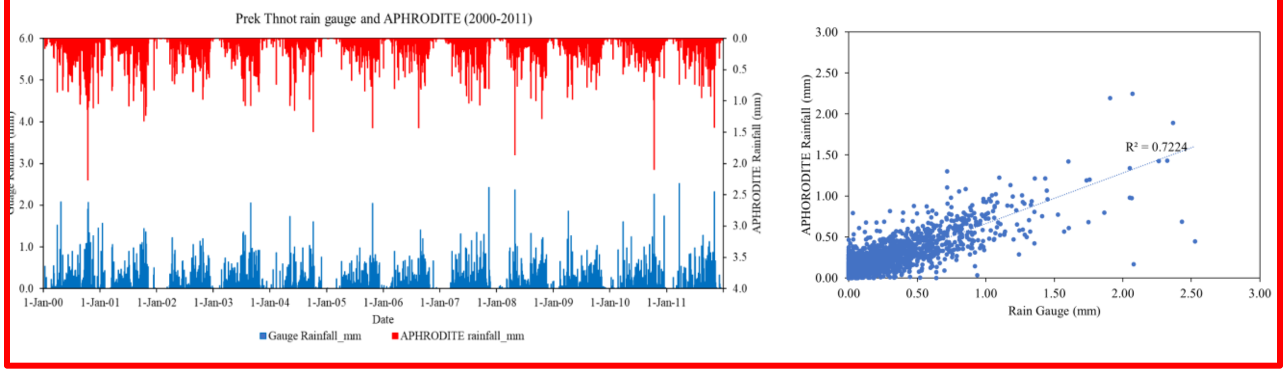
Flood Depth

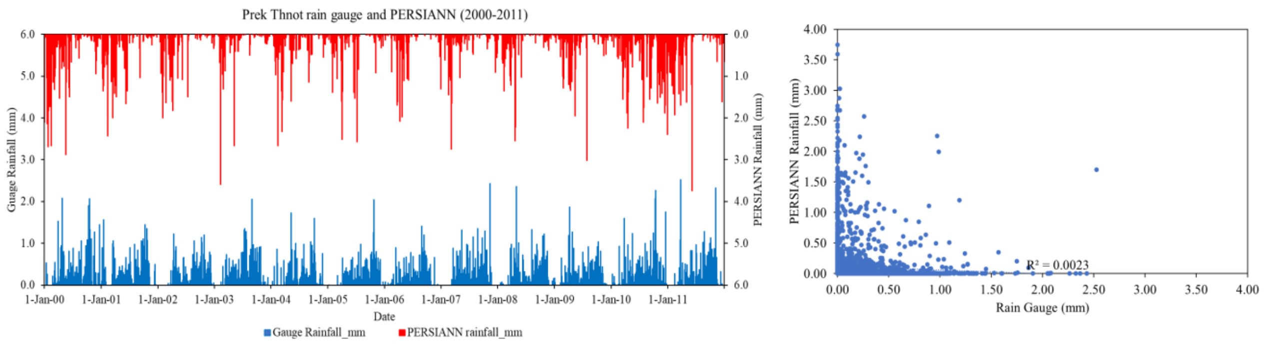


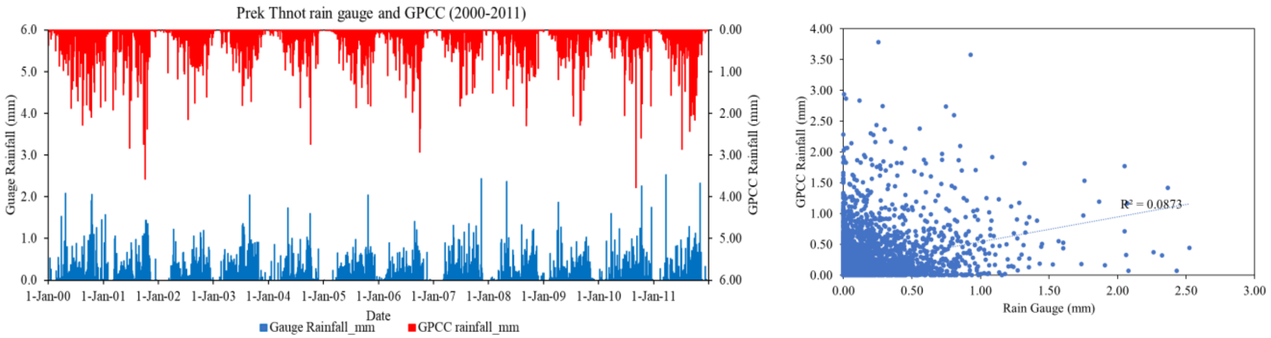
Flood Extend

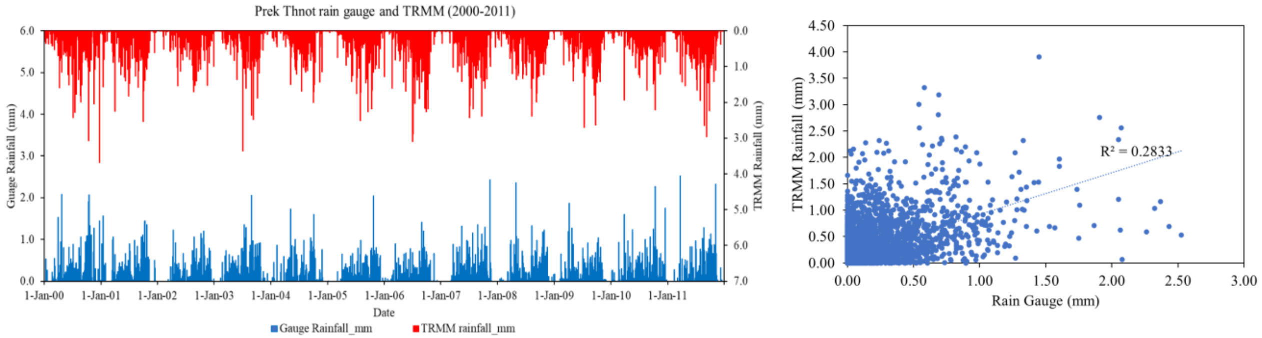
3. Result (Cont.)

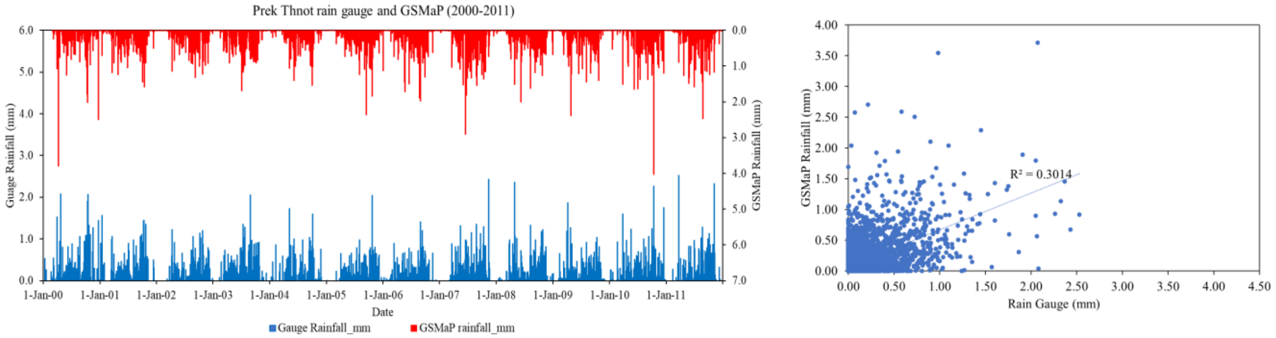
3.3. Performance of Gridded Precipitation Datasets







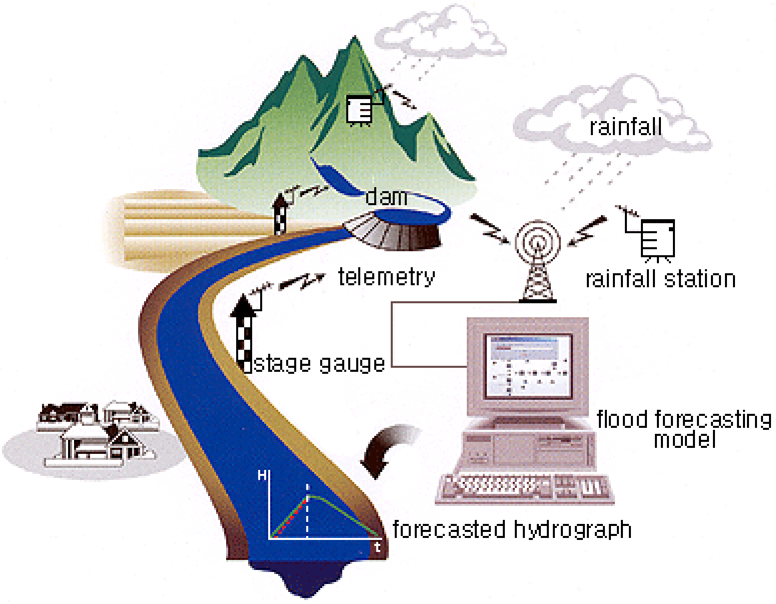




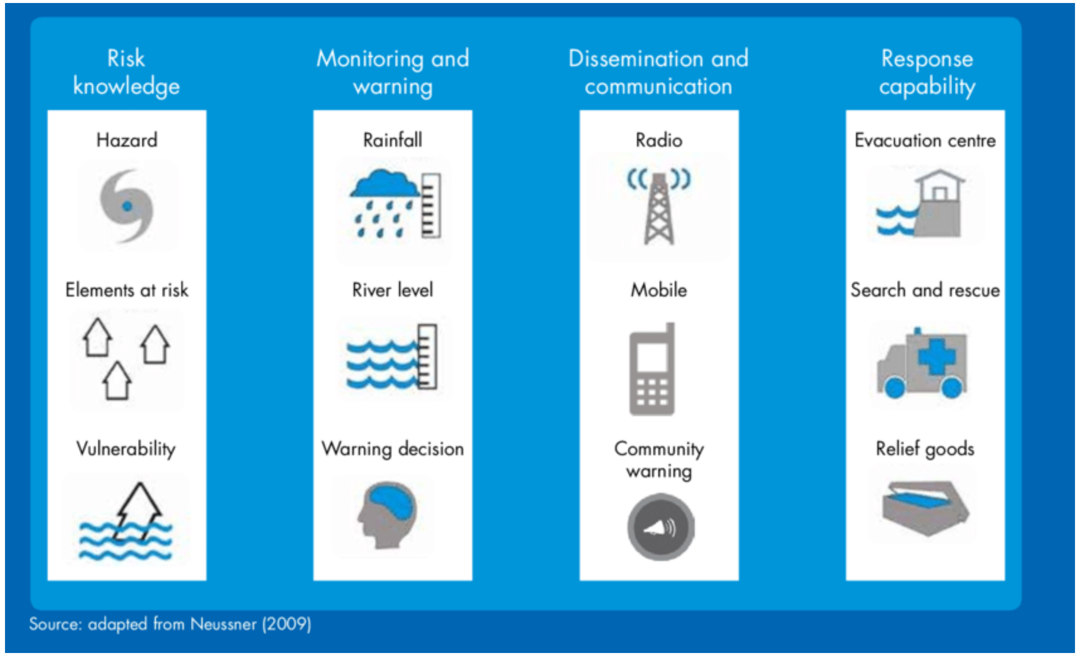
4. Conclusion

- The rainfall-runoff and inundation modeling in the Prek Thnot River Basin have good performance in both river discharge and flood extent.
- The APHRODITE gridded precipitation datasets was the best-fit dataset compared to the rain gauge. These might be useful for further long-term hydrological modeling simulation in the basin.

Using Model for Future prediction?

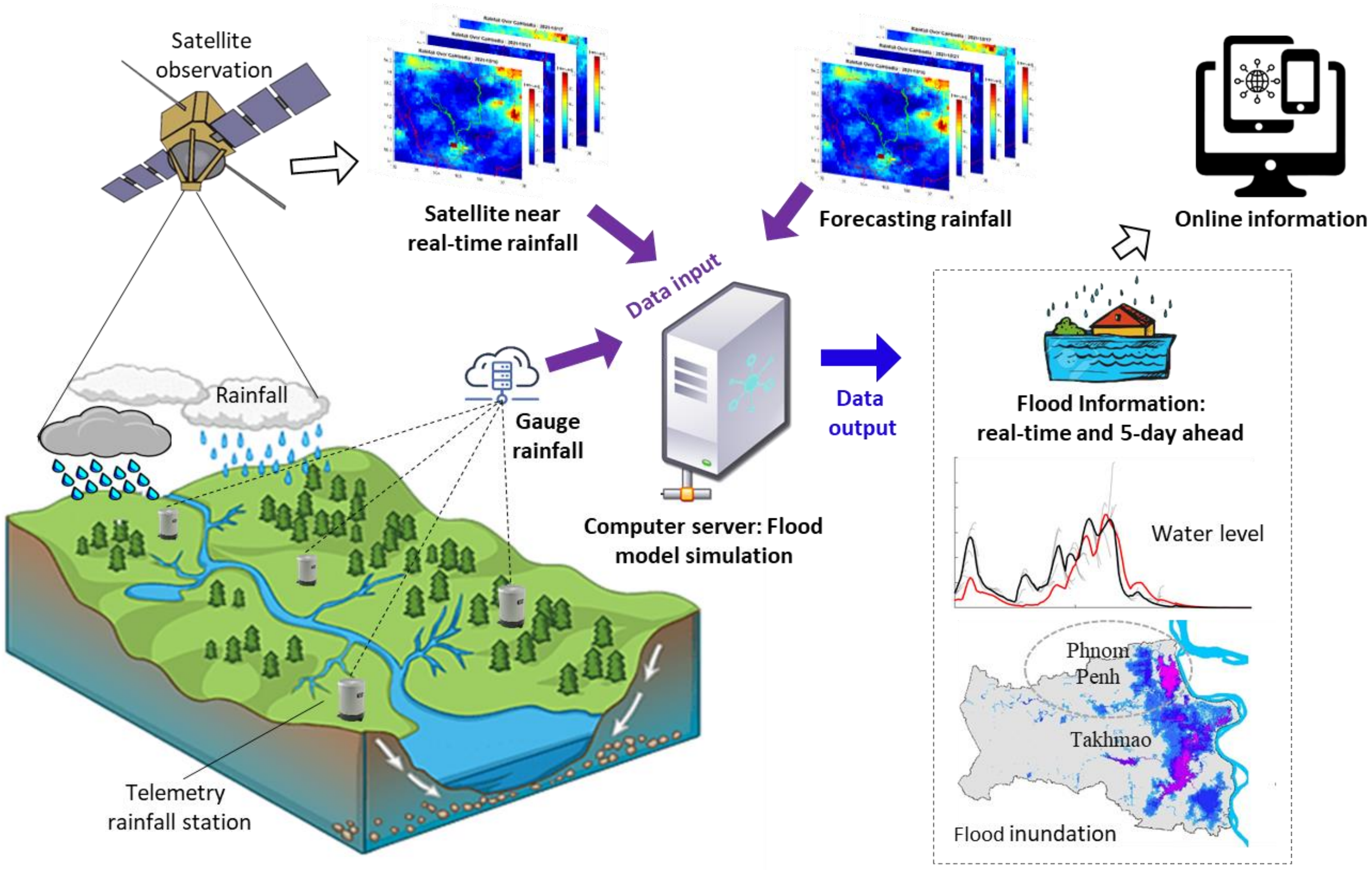


Concept of Flood Forecast



5. Future Works

- Our future work is to develop a flood early warning system in the Prek Thnot River Basin to predict the flood situation in forthcoming 5-day. This system would provide a primary information for preparation of flood mitigation and response for any severe flood event.



Framework of Proposed Flood Forecasting System in the Phnom Penh City and Stung Prek Thnot River

6. Acknowledgement

Authors would like to acknowledge and thank the Cambodia Higher Education Improvement Project (Credit No. 6221-KH), for their financial support.

HydroMet and Disaster Management Lab

Contact:

OEURNG Chantha, PhD
Deputy Director
Institute of Technology of Cambodia,
Russian Federation Blvd, PO. Box 86, Phnom Penh
Mobile: +855 (0) 12 895 840
Email : chanthaposat@yahoo.com
/chantha@itc.edu.kh/oeurng.chantha@gmail.com

SOK Ty, PhD
Lecturer-Faculty of Hydrology and Water Resources
Researcher-Research and Innovative Center
Institute of Technology of Cambodia,
Email :sokty@itc.edu.kh
Mobile :(+855)11980698