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ASSESSING FLOOD INUNDATION IN THE LOWER PREK THNOT RIVER BASIN UNDER CLIMATE CHANGE USING RRI MODEL COUPLED WITH SWAT

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Contents

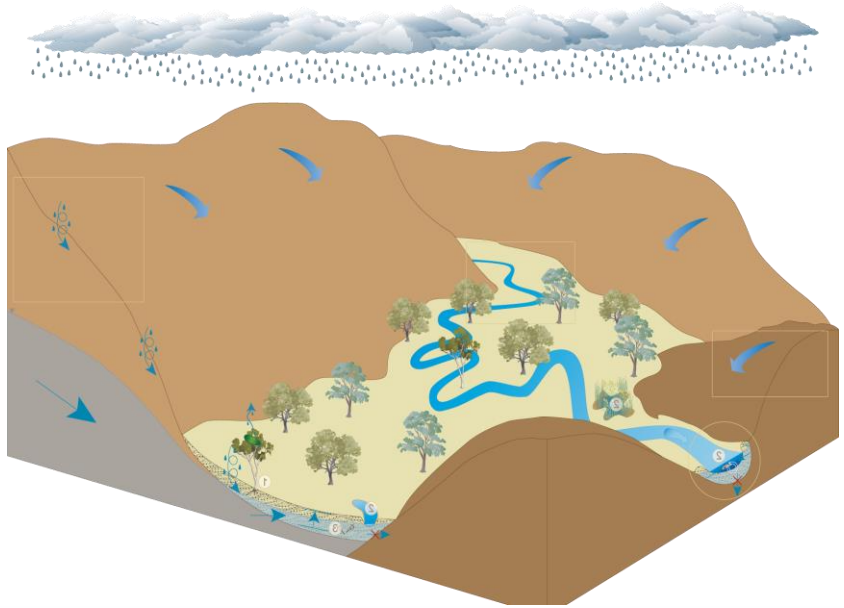
Background

- Climate change alters rainfall patterns

⇒ changes in hydrological characteristics (e.g. streamflow, water level)

⇒ changes in the variety of extreme events (i.e. floods and droughts)

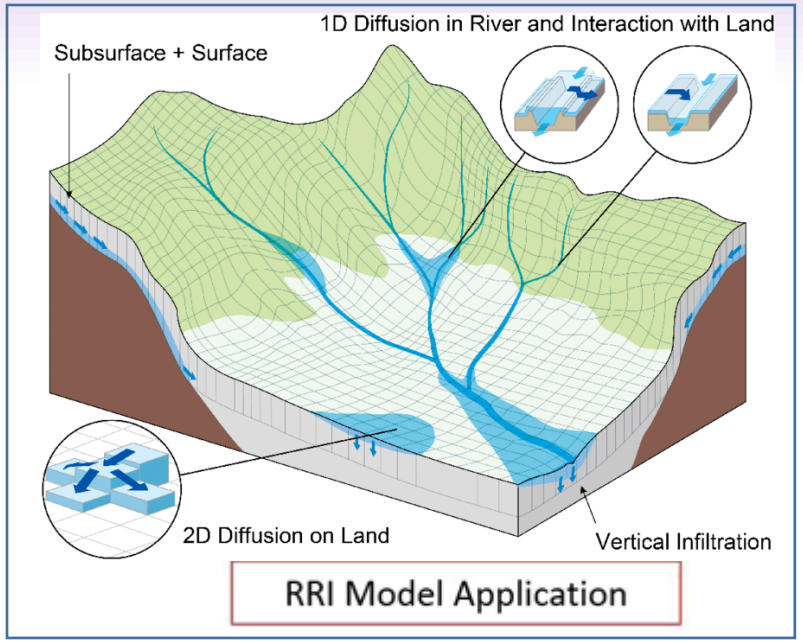
- Climate change impacts on extreme events in Cambodian basins:
  - ❑ More intense floods are expected between 2075 and 2099 in the lower Mekong River Basin.
  - ❑ More droughts and less floods are projected to happen by 2100 in the Tonle Sap Lake Basin.



Objectives

1 Simulation of hydrological features and flood inundation using the Rainfall-Runoff-Inundation (RRI) model during large flood events in the lower Prek Thnot River Basin with baseline discharge from SWAT.

2 Investigating percentage change for a possible flood event in the 2030s and 2060s under two RCPs (RCP2.6 & RCP8.5) using three GCMs such as GFDL-CM3, GISS-E2-R-CC, IPSL-CM5A-MR.



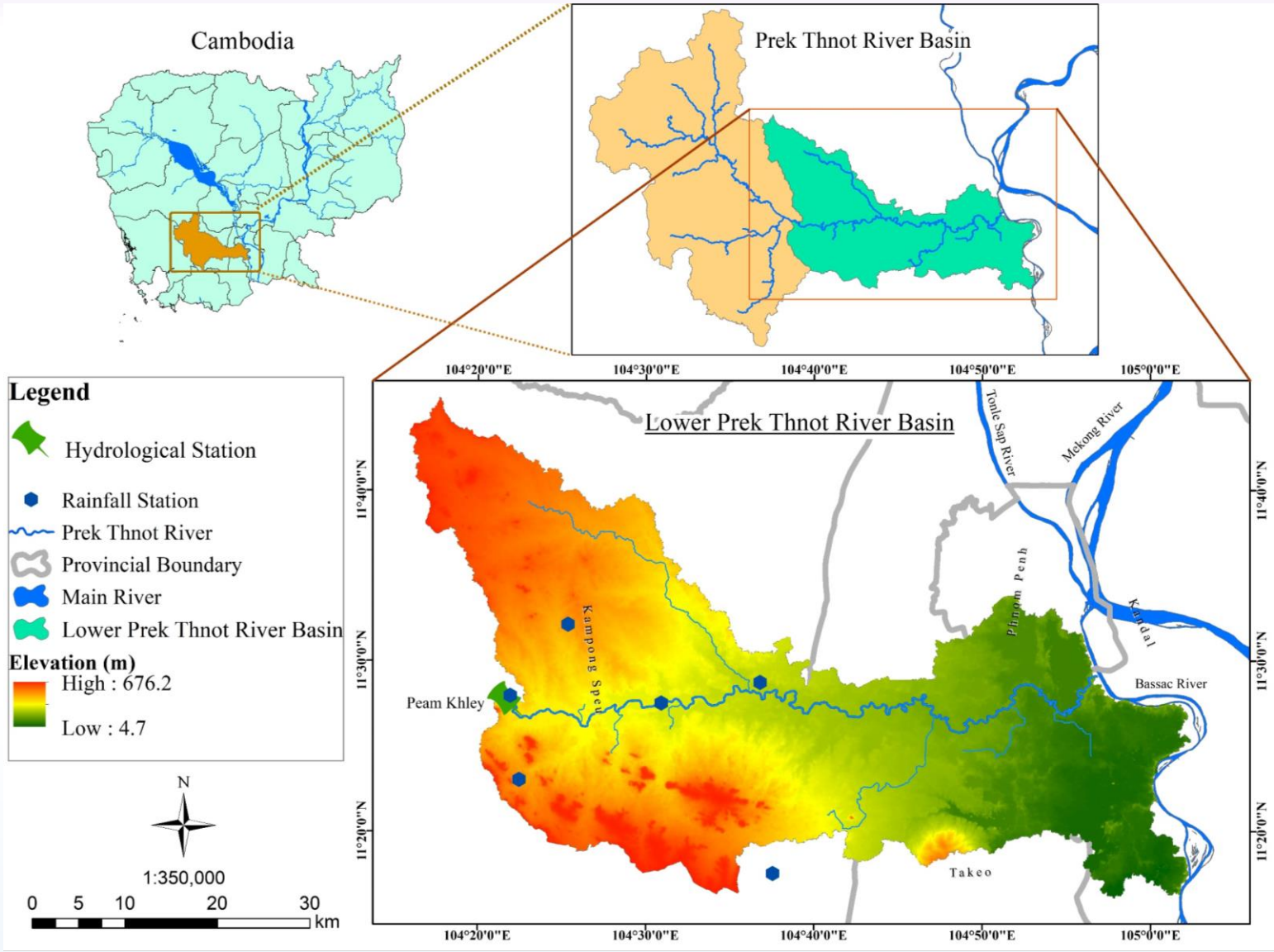
General Circulation Models (**GCMs)**
GFDL-CM3
GISS-E2-R-CC
IPSL-CM5A-MR

Pattern of change
– wetter overall
– drier overall
– increased seasonal variability

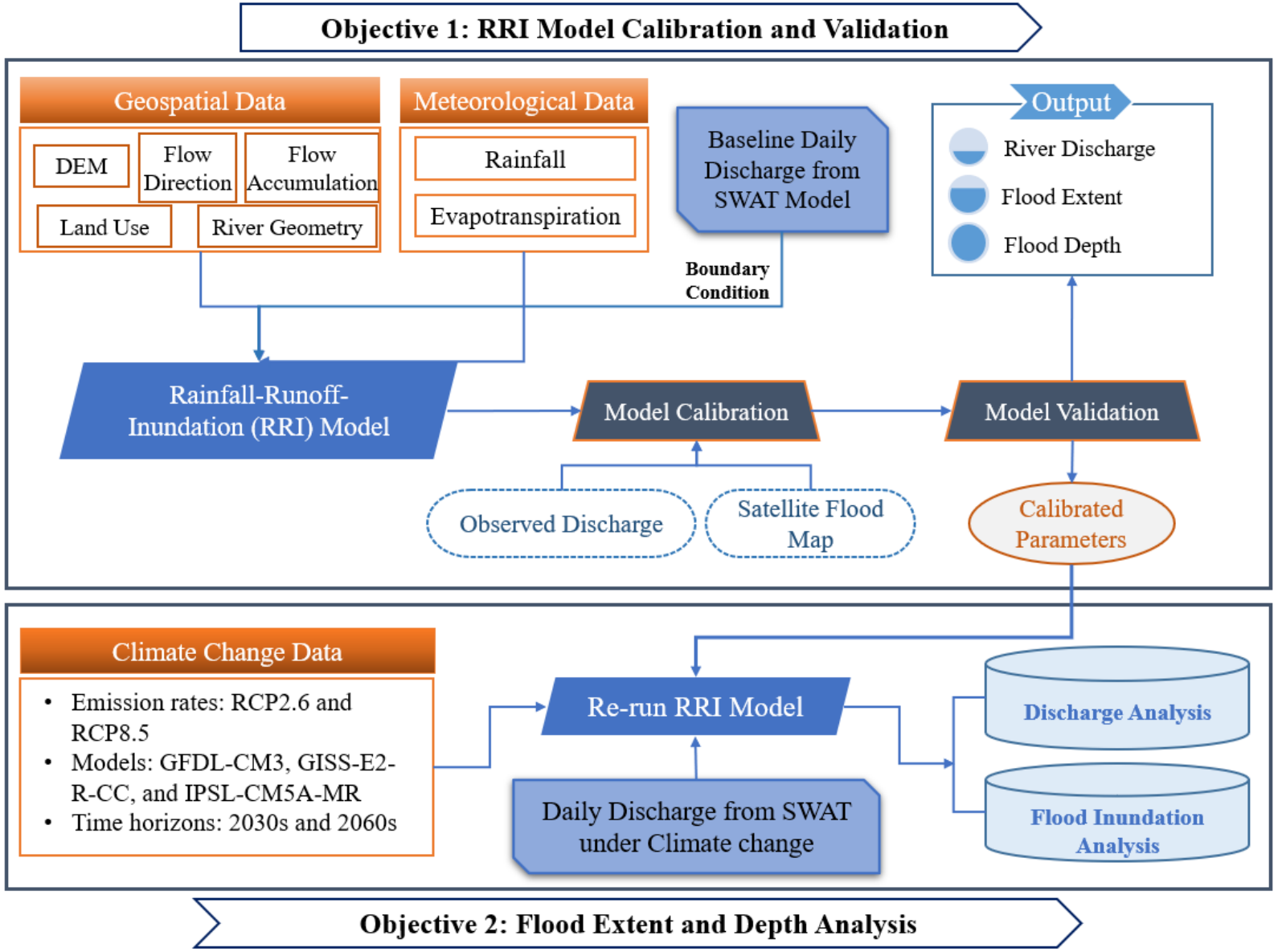
Study Area

The lower Prek Thnot River Basin

- Area: 2,035 km^2
- Partly covers: Kampong Speu, Kandal, Takeo and Phnom Penh
- Average annual rainfall: 1,225 mm
- Maximum flood discharges: 1,371 m^3/s (1991) & 1,304 m^3/s (2000)



RRI Model Simulation & Flowchart



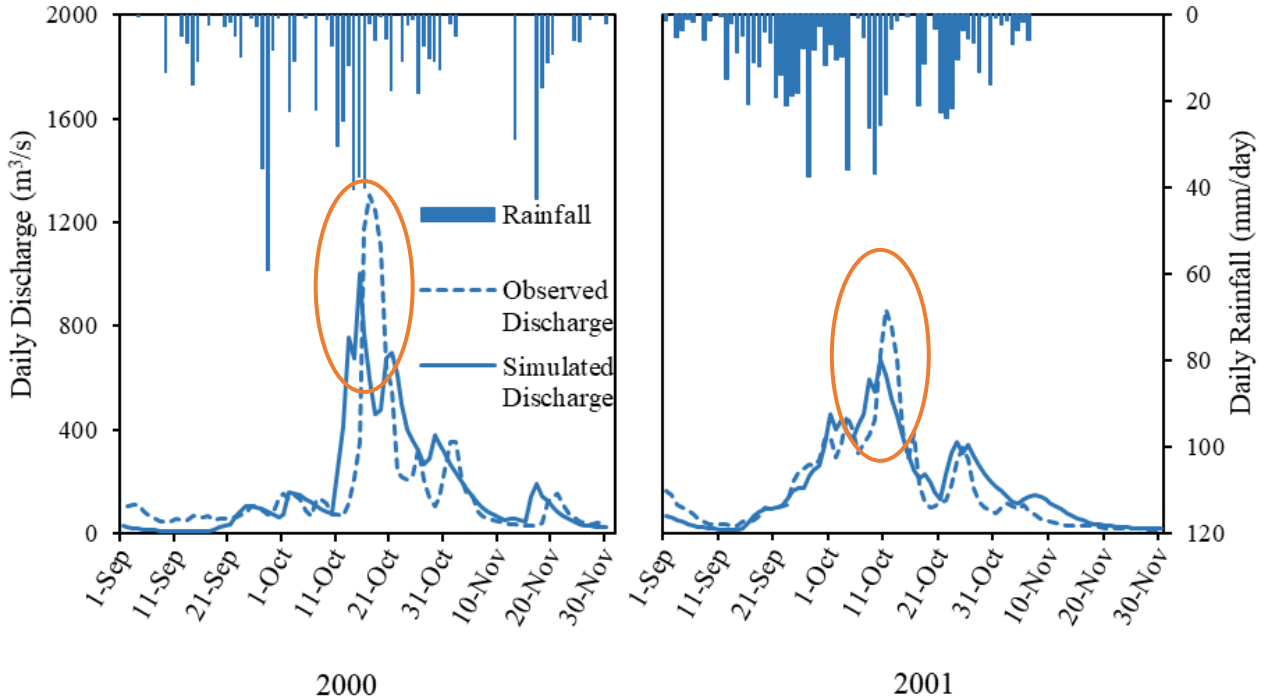
- The model was set up at 500 m at a daily time-step from September to November.
- Calibrated for the 2010 flood event, validated for the 2000, 2001, 2020 events.
- Baseline flow & flow under climate change from SWAT inputted into the RRI model at Peam Khley station (inlet).
- The 2000 peak flood event was set as baseline for climate change.
- Model performance statistical indices are:

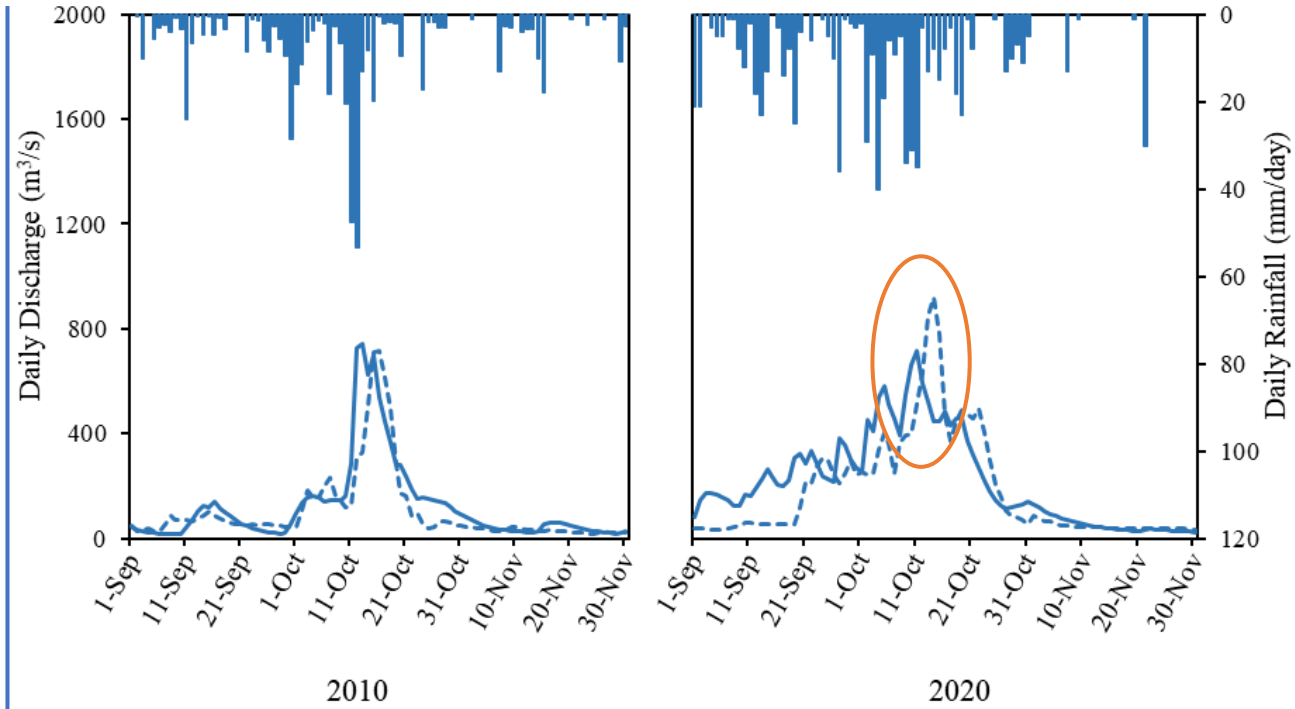
  NSE, PBIAS, RSR, R^2 (discharge)

  Hit ratio (HR) & True ratio (TR) (flood map)

Model Simulation

Discharge



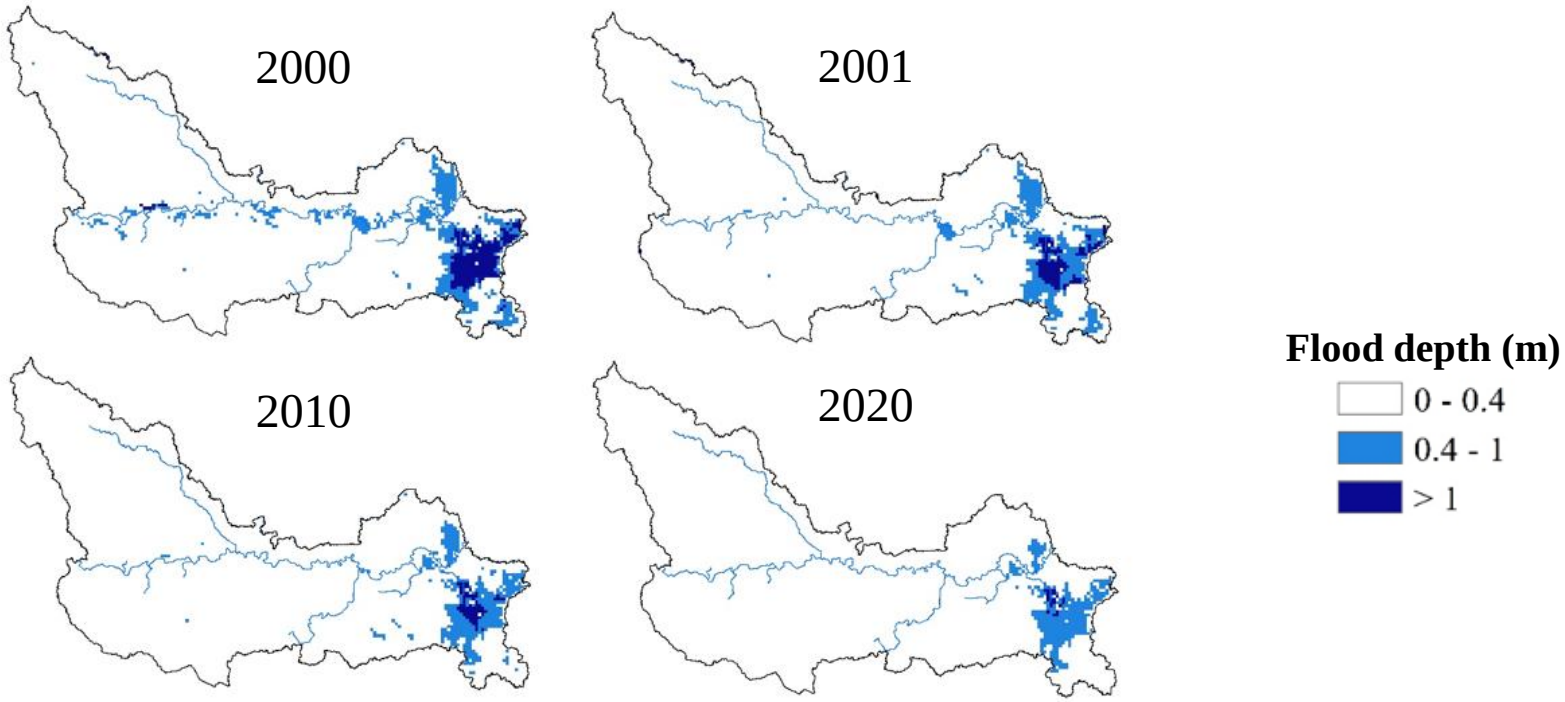


Statistical Index / Flood Event	NSE	PBIAS	RSR	R^2	Overall Remark
2000	0.55	-4.38	0.67	0.57	Satisfactory
2001	0.80	-7.76%	0.44	0.81	Very Good

Statistical Index / Flood Event	NSE	PBIAS	RSR	R^2	Overall Remark
2010	0.66	-18.16%	0.59	0.74	Good
2020	0.59	-20.17%	0.64	0.63	Satisfactory

Model Simulation

Flood Inundation

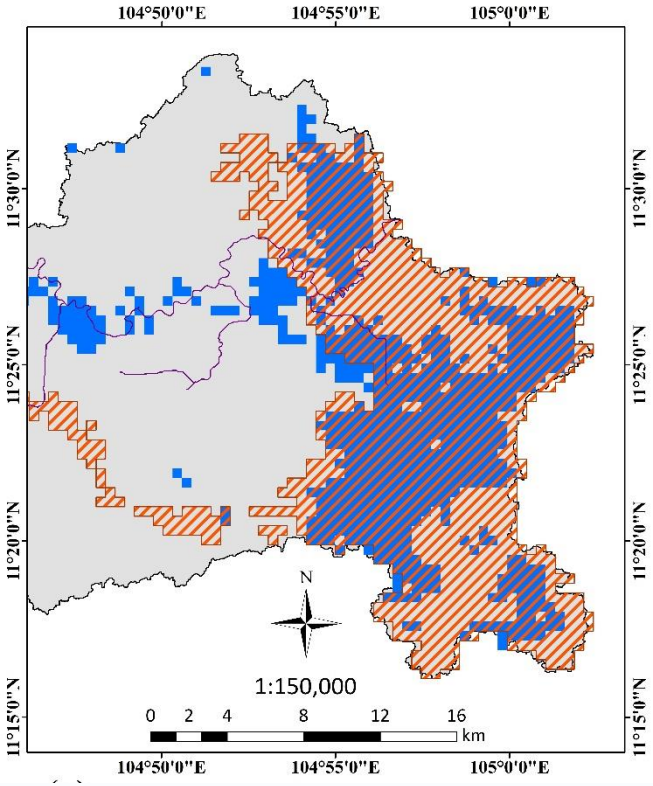


Flood depth (m)	2000	2001	2010	2020
	% of covered area	%	%	%
0.4 – 1.0	6.50	5.45	5.11	4.26
> 1.0	3.15	1.63	0.85	0.26

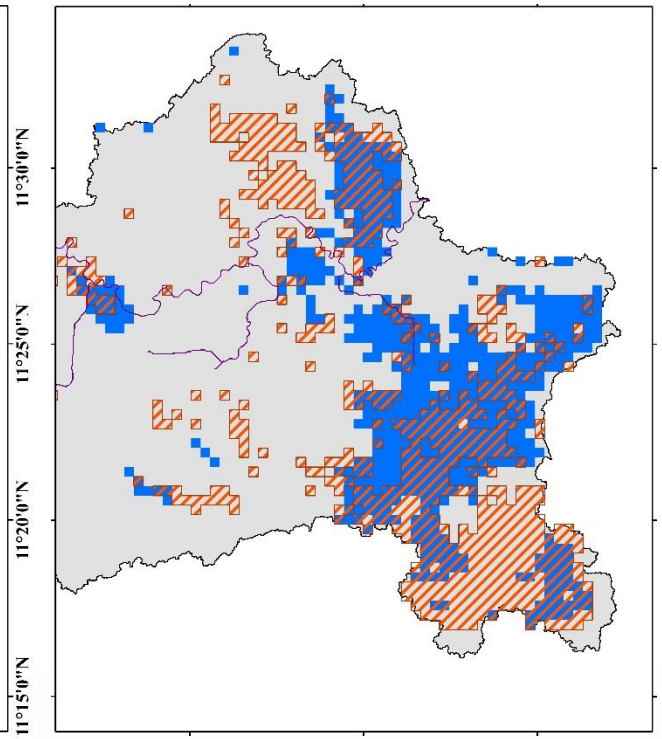
where 1% = 20.35 km^2

Model Simulation

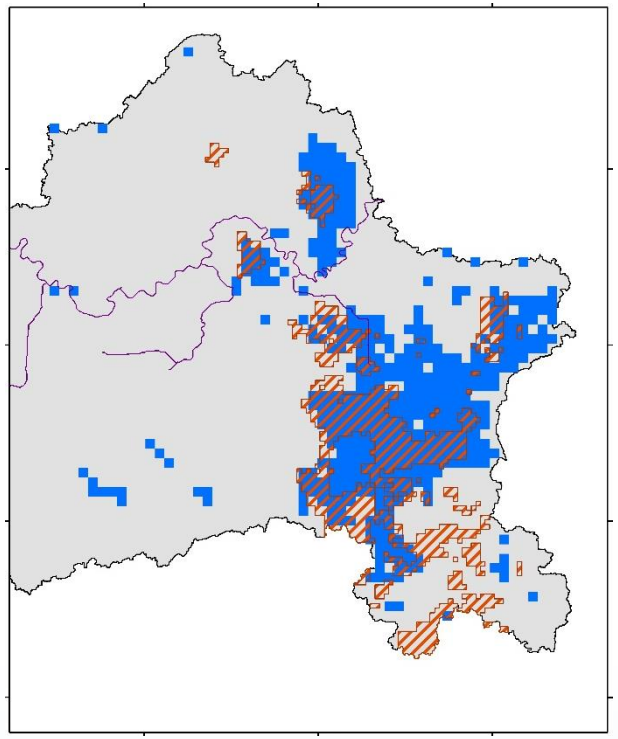
2000 Flood event



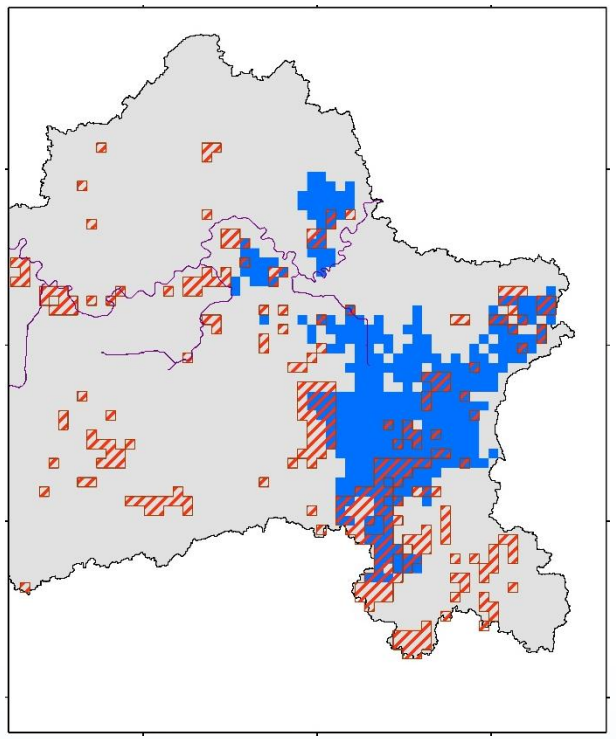
2001 Flood event



2010 Flood event



2020 Flood event



Satellite Flood Map

Inundated Area

RRI Simulation

Inundated Area

Performance Indices	2000	2001	2010	2020
True Ratio (TR)	72%	48%	34%	27%
Hit Ratio (HR)	49%	43%	62%	35%

Effects of Climate Change

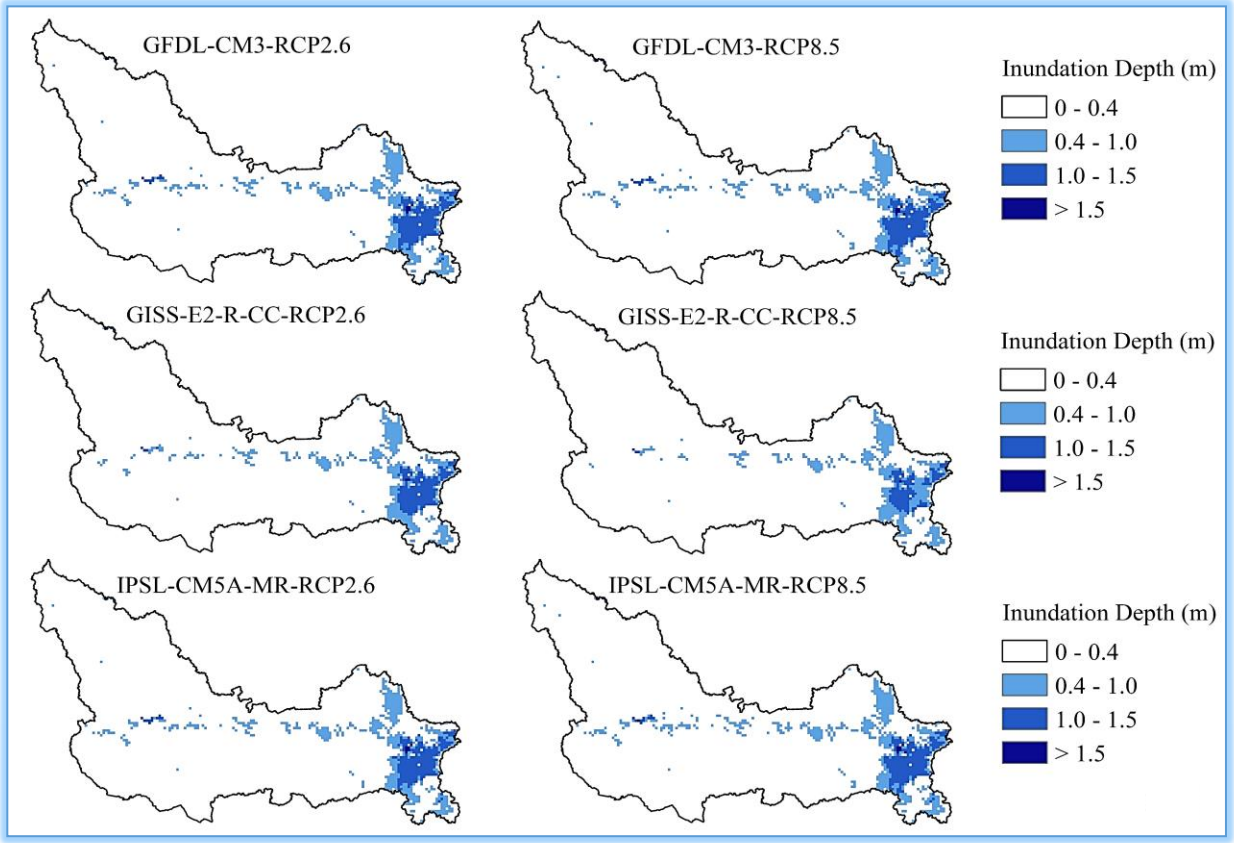
Discharge

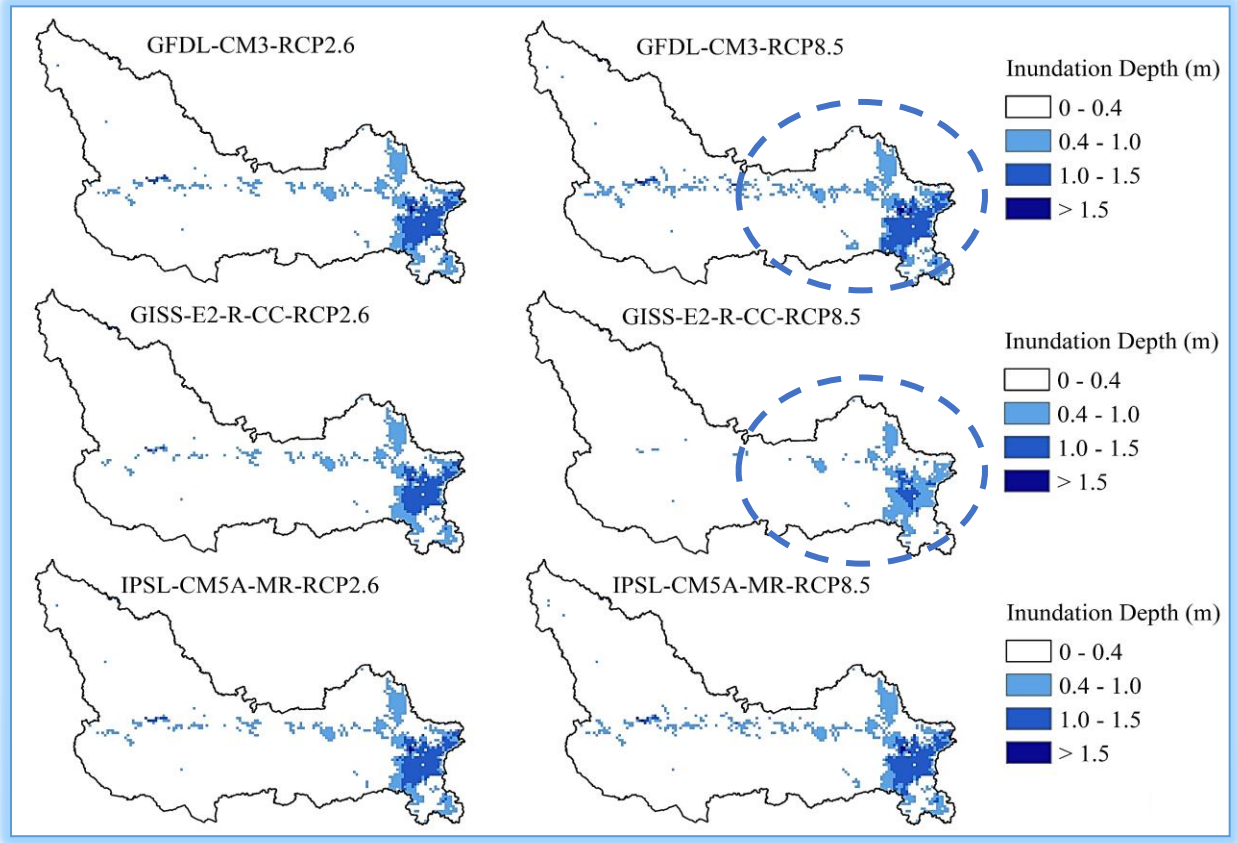
Time horizons	GCMs	Scenario	Q_m (%)	Q_5 (%)
2030s	GFDL-CM3	RCP2.6	4.5	3.9
		RCP8.5	11.3	8.4
	GISS-E2-R-CC	RCP2.6	-7.5	-8.4
		RCP8.5	-34.8	-21.4
	IPSL-CM5A-MR	RCP2.6	0.4	1.7
		RCP8.5	-10.6	4.2
2060s	GFDL-CM3	RCP2.6	3.4	3.1
		RCP8.5	19.7	13.5
	GISS-E2-R-CC	RCP2.6	-5.4	-6.4
		RCP8.5	-45.2	-39.3
	IPSL-CM5A-MR	RCP2.6	0.8	1.3
		RCP8.5	-13.9	-1.6

Baseline Q_m = 86.47 m^3/s; Q_5 = 675.5 m^3/s

Effects of Climate Change

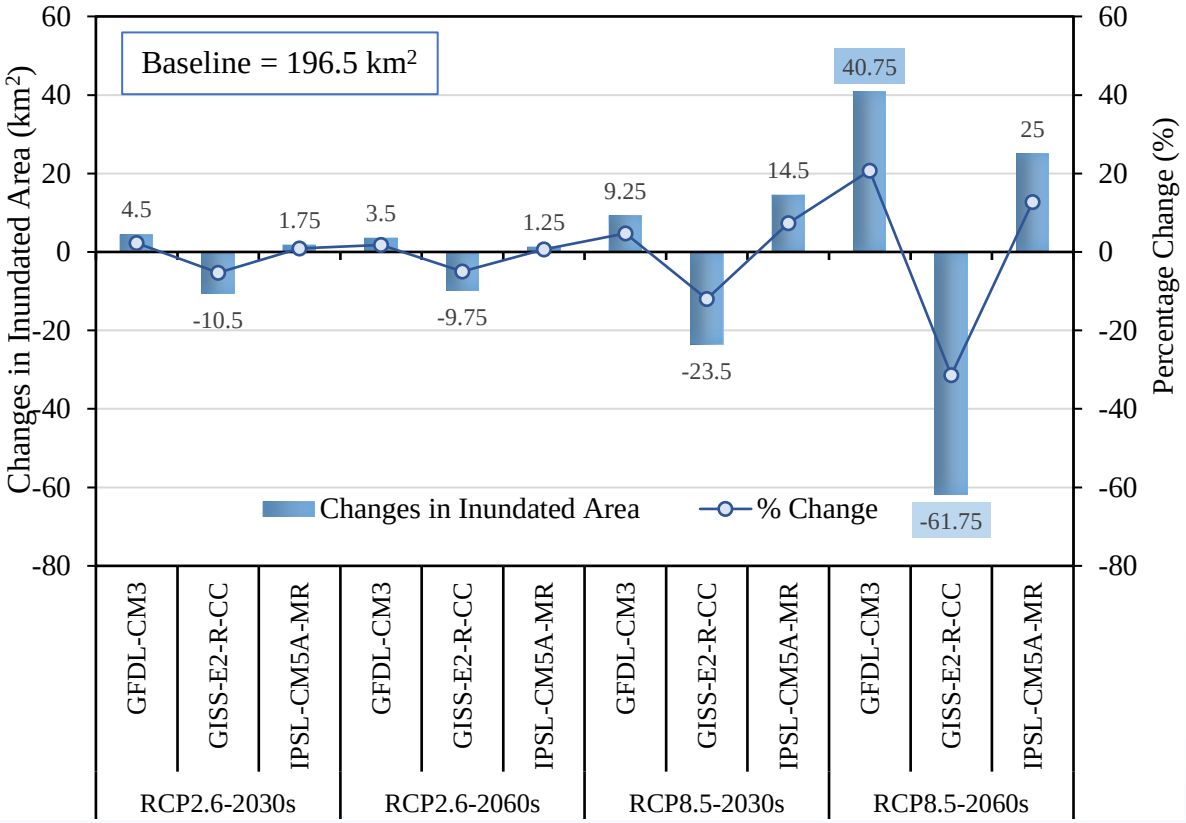
Flood inundation



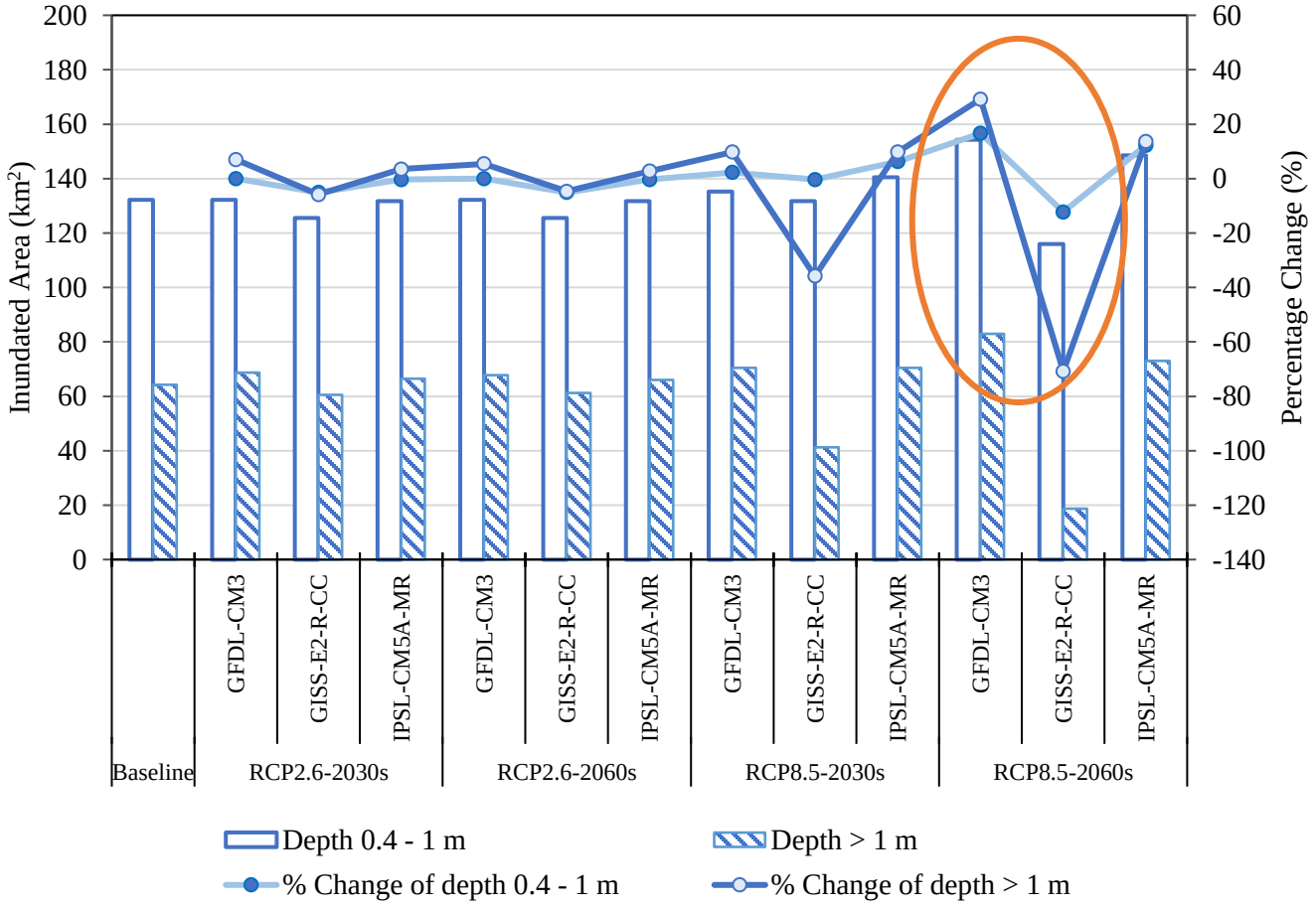


Effects of Climate Change

Overall flood extent change



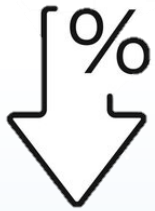
Flood extent change varying with flood depth



Conclusion

- The RRI model integrated with SWAT is **applicable** in the lower Prek Thnot River Basin.
- Flood inundation will become more **intense** using the GFDL-CM3 and IPSL-CM5A-MR models, and **less severe** using the GISS-E2-R-CC model, especially under RCP8.5 during both future periods.

- **2030s**: changes in precipitation between -8% and 22% could lead to changes in
  - Q_5 from -21%–8%,
  - peak water level from -6%–1%
  - inundation area from -12%–7%



- **2060s**: changes in precipitation between -18% and 46% could lead to changes in
  - Q_5 -39%–14%
  - peak water level from -20%–5%
  - inundation area from -31%–21%

Recommendation

- More ground-observed rainfall stations should be installed for better rainfall distribution in the basin.
- Resolution should be reduced to a finer one to assure more accuracy especially for flood map validation.
- Up-to-date input data including land use and river geometry data should be made available and considered for more accurate and rectified simulation.
- Satellite rainfall should be investigated for its efficacy and used for long-term study.

Acknowledgements

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