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ICOLD Technical Committee Y « Climate Change »

Workshop « **Climate Change: Risks & Opportunities for Dams, Reservoirs and Hydropower** » - May 28, 2022

# Case Study: South-East Asia Climate Change Impacts on Extreme Flood Inflow

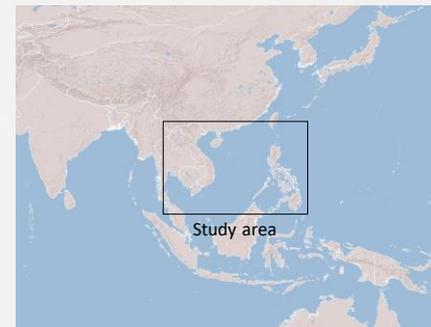
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ICOLD TC Y Workshop 2022-05-28



AFRY  
Å F PÖRY

# Overview

- Clients
  - Private hydropower development and operation companies (confidential)
  - Lao PDR, Philippines
- Context
  - Existing dams: dam safety reviews
  - Planned dams: information for climate resilient design
  - Hydropower installed capacity: 70 MW to 700 MW
  - Catchment areas: 500 km<sup>2</sup> to 15,000 km<sup>2</sup>
- Execution period
  - 2015-2020

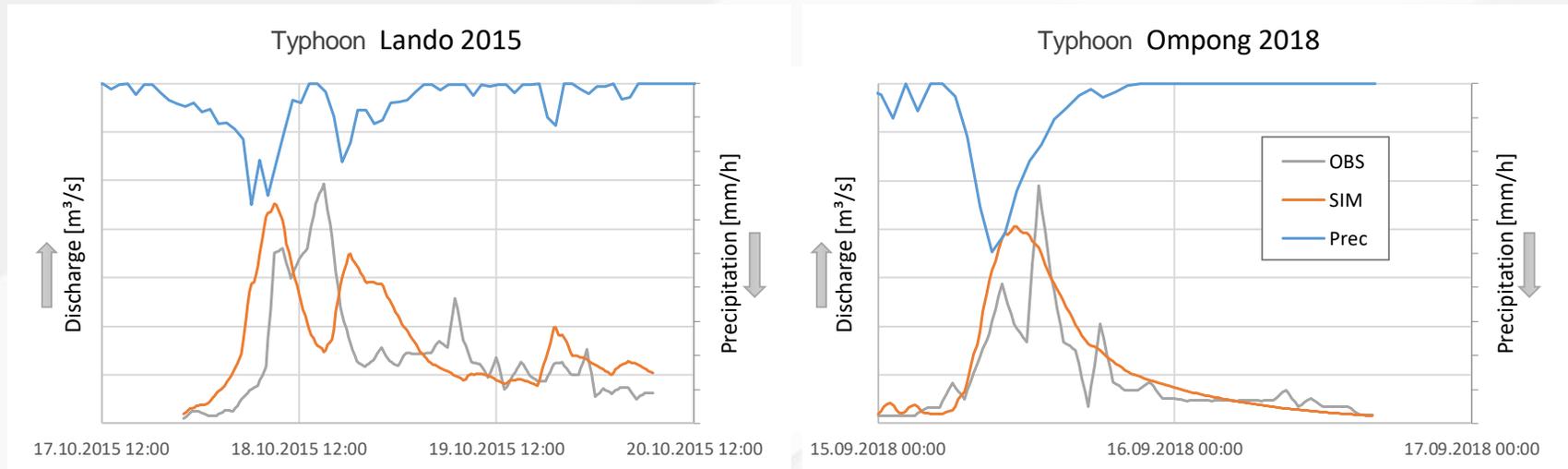


# Problem statement and objectives

- Many existing/new dams in South-East Asia are located in flood-prone areas under both monsoon and typhoon influence.
- Extreme rainfall and floods
  - Very dynamic and high floods
  - Global warming: a warmer atmosphere can hold more moisture  
-> future extreme storms are expected to exhibit higher rainfall intensities and depths
- Study objectives
  - Assessment of the impact of climate change on future extreme flood inflow.

# Methodology

1. Set-up of a rainfall-runoff model
2. Calibration with rainfall and observed discharge from historical storm events



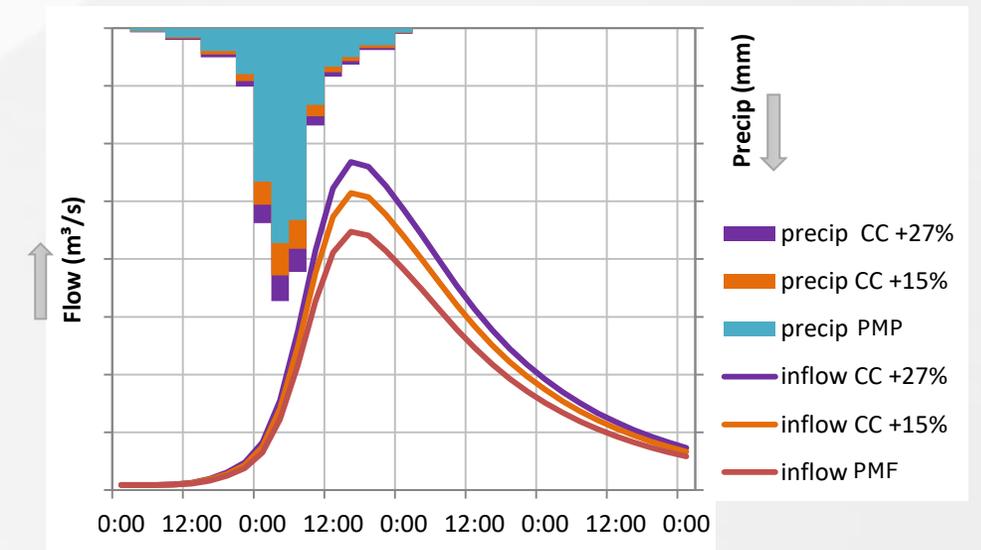
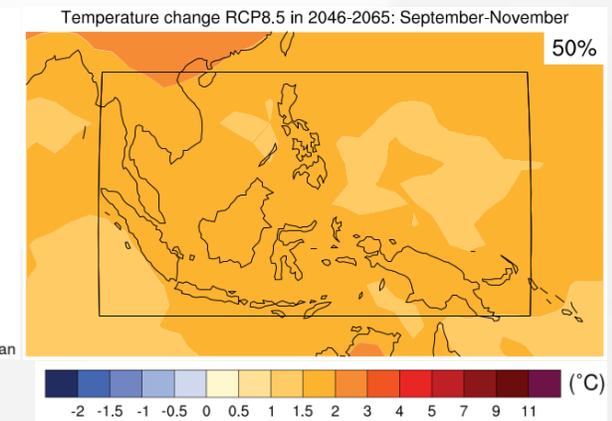
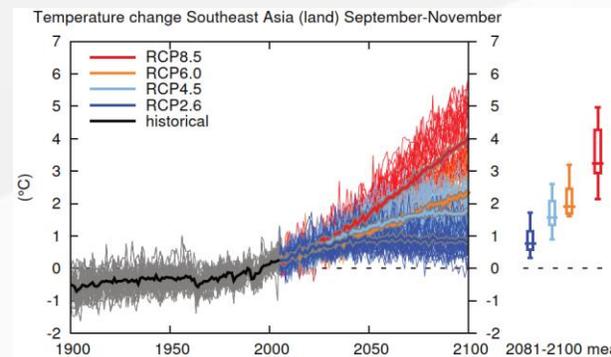
3. Definition of extreme storms under current conditions  
PMP, WMO guideline, based on analysis of observed rainfall data
4. Definition of scenarios of future changes in extreme storms
5. Simulation of extreme flood inflow under current and future climatic conditions

# Future extreme rainfall

- Info available in literature:
  - IPCC reports
  - Scientific publications, e.g. Fei Ge et al., 2019 (SE-Asia extreme rainfall)
  - Reports on regional climate modelling and downscaling, e.g. PAGASA (Philippines)
- Climate model projections:
  - High uncertainty for future tropical cyclones
  - Decrease in cyclone frequency possible
  - Increase in cyclone rainfall intensity
- Clausius-Clapeyron relationship
  - appr. 7% increase in water holding capacity per °C warming
  - good proxy info for future change in PMP
- Future scenarios for extreme storms
  - Use Clausius-Clapeyron relationship with projected warming for study area
  - Spatio-temporal storm patterns were not altered

# Results

- Results depend on:
  - Future warming level (emission scenario)
  - Study region (catchment)
- Example results:
  - Extreme rainfall +15% middle of 21<sup>st</sup> century
  - Extreme rainfall +27% end of 21<sup>st</sup> century
  - With corresponding simulated changes in flood inflow
- Adaptation measures:
  - Design of spillway structures
  - Adaptation of reservoir operation rules
  - Flood warning systems
  - etc.



# Challenges and Conclusions

- Limited observation data for historic storms in remote catchment areas.
  - Despite this challenge, rainfall-runoff models provide robust estimates for the rainfall-runoff transformation characteristics.
  - Climate model projections for extreme rainfall are very uncertain.
  - Plausible “scenarios” can be developed with the presented methodology.
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- More details are available in the Case Study Report of the ICOLD Bulletin.

**Thank you!**