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HS2.5.2

Countermeasures against flood in the Chao Phraya River Basin, Thailand - Assessment and adaptation to combat climate change

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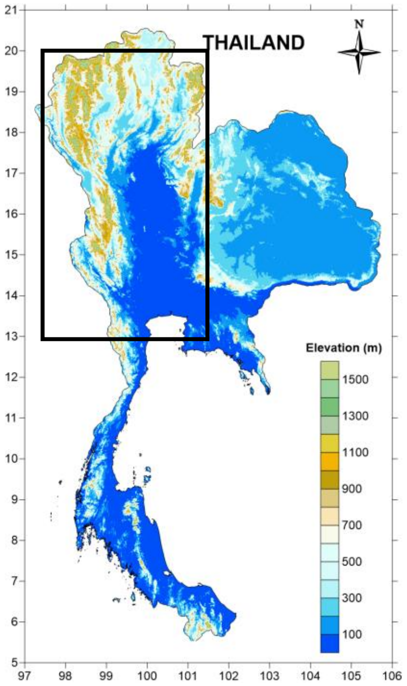
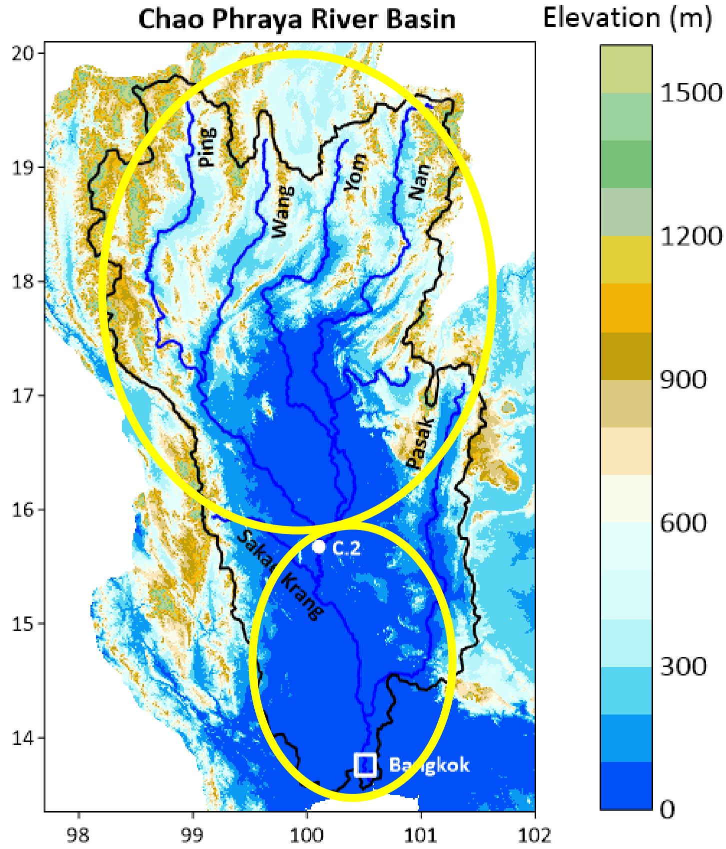
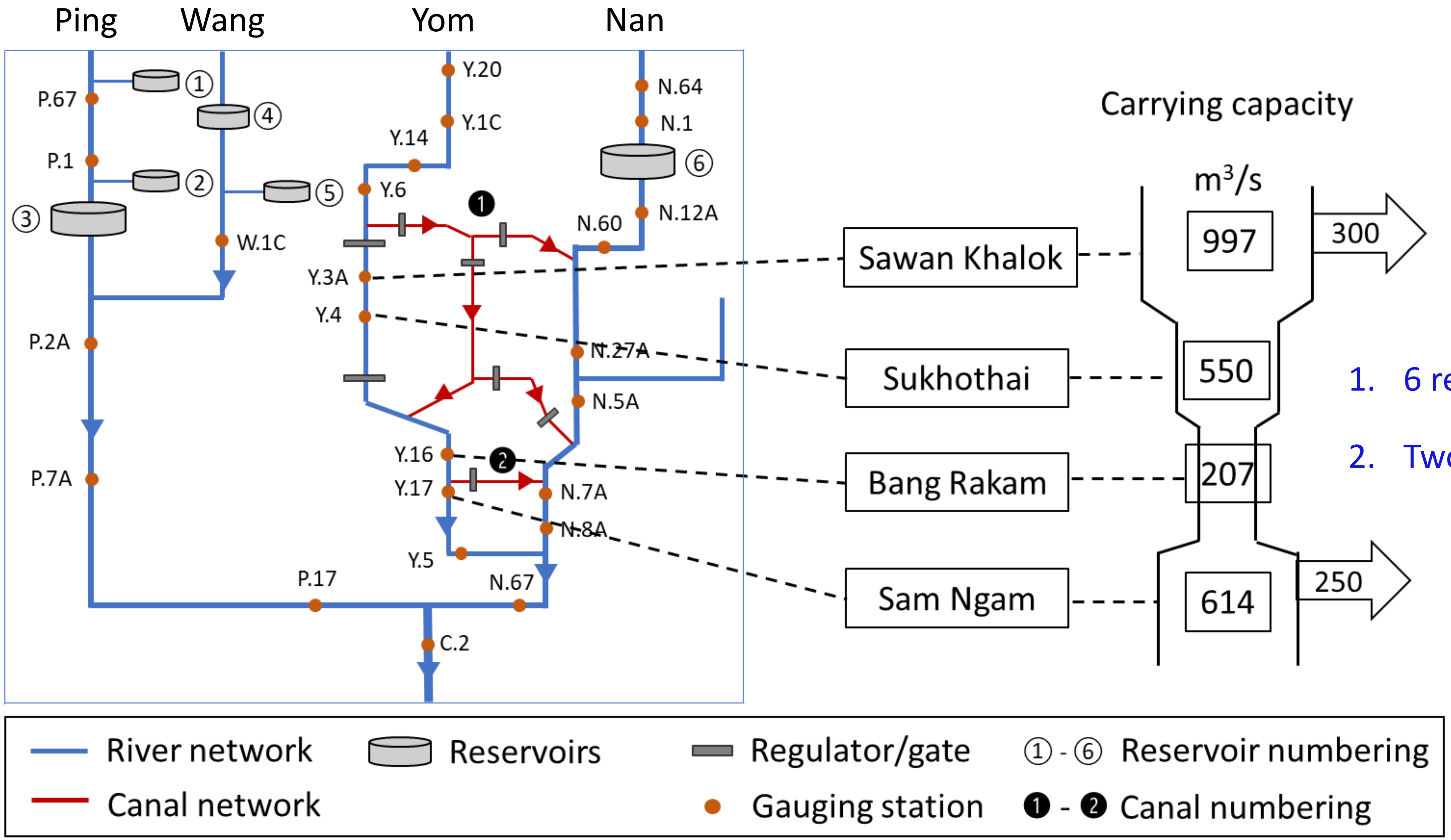
BACKGROUND

- Climate change (CC) will exacerbate the flood risk in Thailand, the 2nd largest economy in Southeast Asia
- Chao Phraya River is the largest river system in Thailand (30% area of Thailand)
- Chao Phraya River Basin (CPRB) has divided into,
    - Upper basin (until Nakhon Sawan, C2 station)
    - Lower basin (After C2 station)
- Flooding is regular in the CPRB due to
    - Gentle slope in various parts
    - Lack of major flow regulation structures
    - Low channel carrying capacity





FLOOD CONTROLLING MEASURES IN THE UPPER CPRB

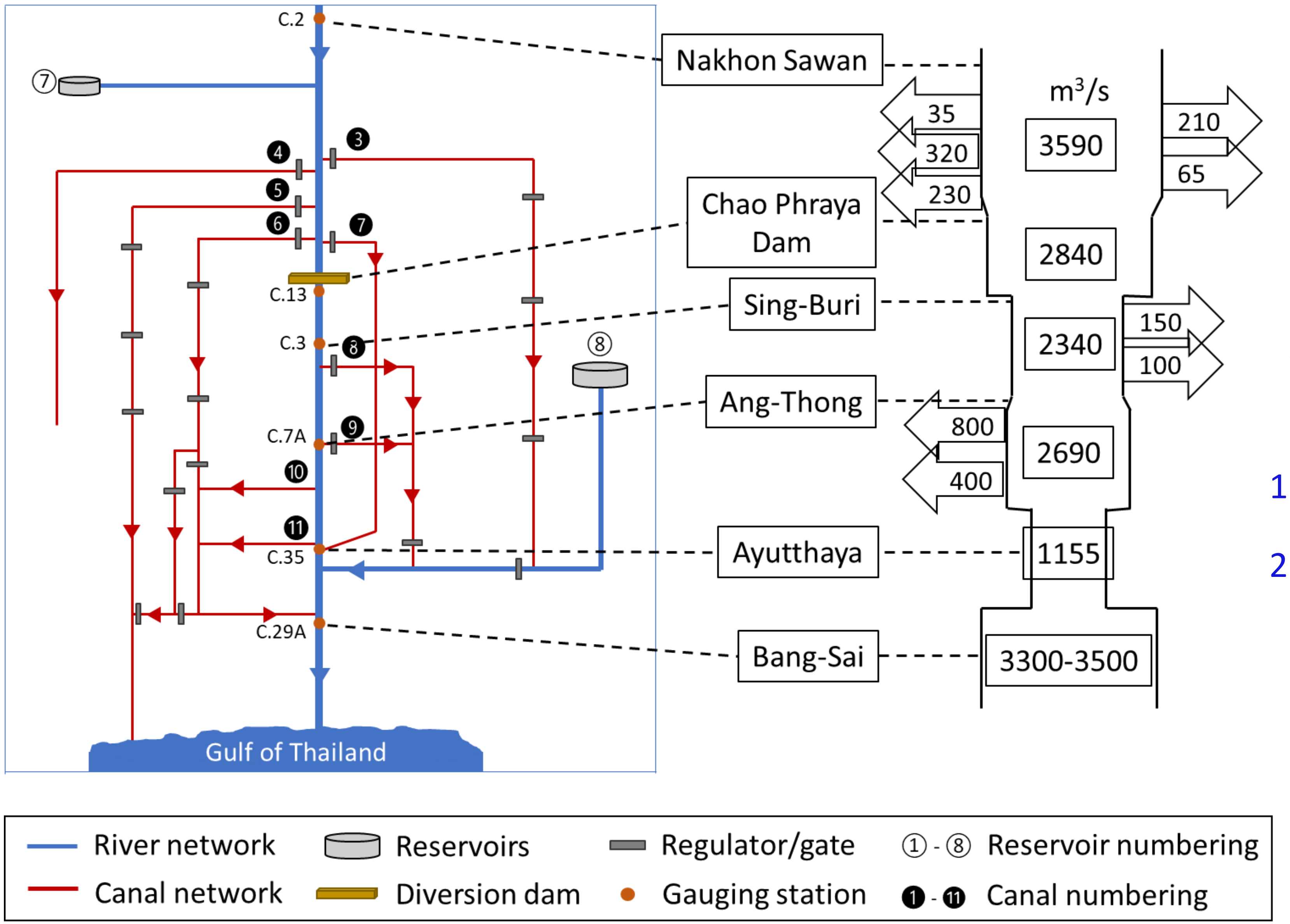


1. 6 reservoirs in the upper basin
2. Two flood diversion canals

1. Lack of major flow regulation structures
2. Low channel carrying capacity at various locations

Frequent flooding in Yom basin

FLOOD CONTROLLING MEASURES IN THE LOWER CPRB



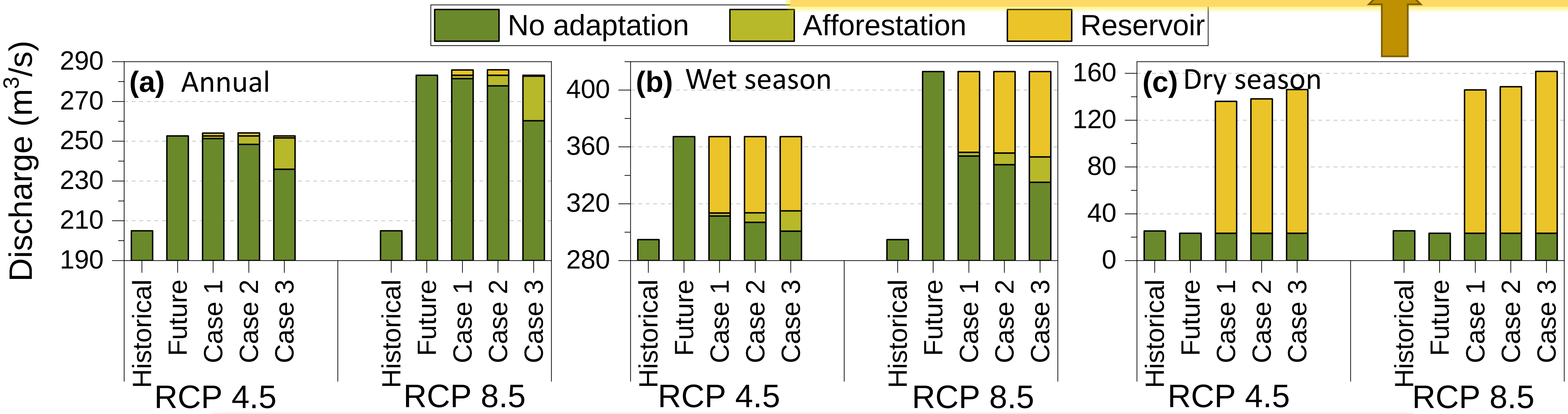
1. 2 reservoirs in the lower basin
2. nine flood diversion canals

1. A total of 8 reservoirs in the CPRB
2. A total of 11 flood diversion canals

MOTIVATION OF THE STUDY

- Recent studies evaluated the possibility of different adaptation strategies (afforestation and reservoir operation) for reducing the future flood risk in the CPRB

Concluded that further adaptation measures are needed to tackle with the future floods

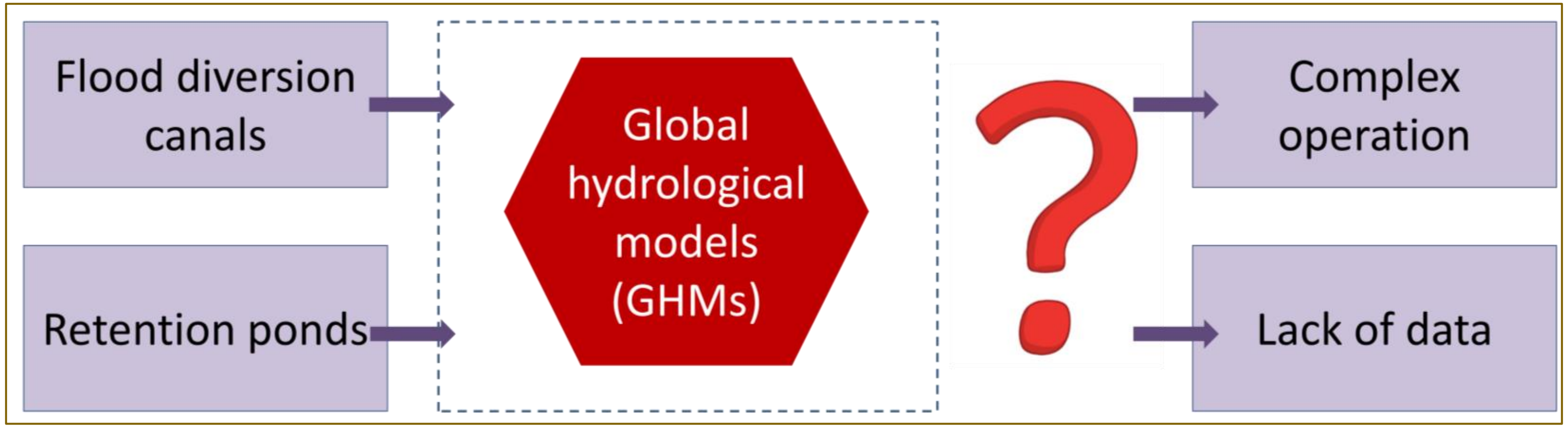


Diversion canals could be a potential adaptation strategy in the CPRB

Afforestation (Takata & Hanasaki, 2020) and reservoir operation (Padiyedath Gopalan et al., 2021)

OBJECTIVES OF THE STUDY

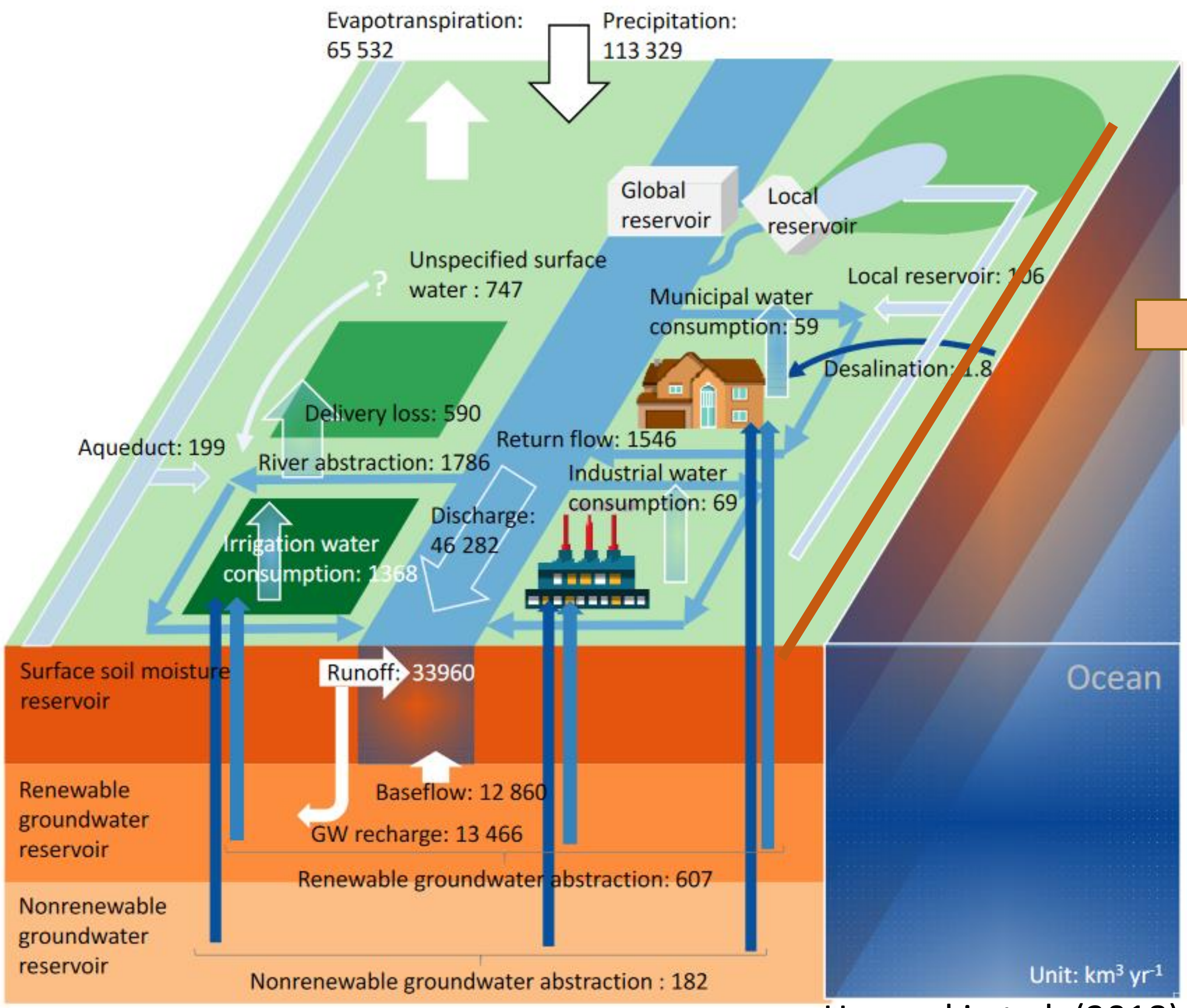
- The CPRB has several natural and man-made diversion canals along with retention ponds



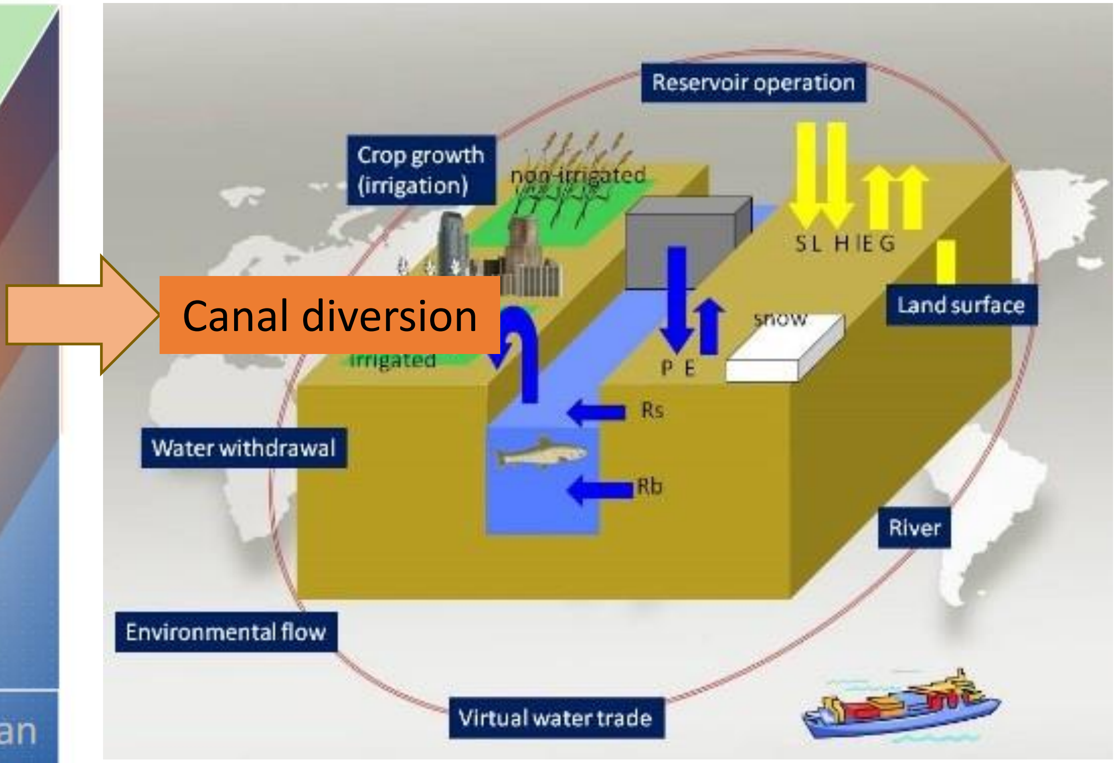
- Recently, Padiyedath Gopalan et al., (2022, accepted) successfully implemented the diversion canals and retention ponds into the H08 GHM (https://hess.copernicus.org/preprints/hess-2021-532/)

- Therefore, this study is going to answer the following two key questions:
  - Whether the existing structural and non-structural measures will suffice to reduce the impacts of CC?
  - Whether we need further adaptation measures to combat the impacts of CC?

H08 GLOBAL HYDROLOGICAL MODEL



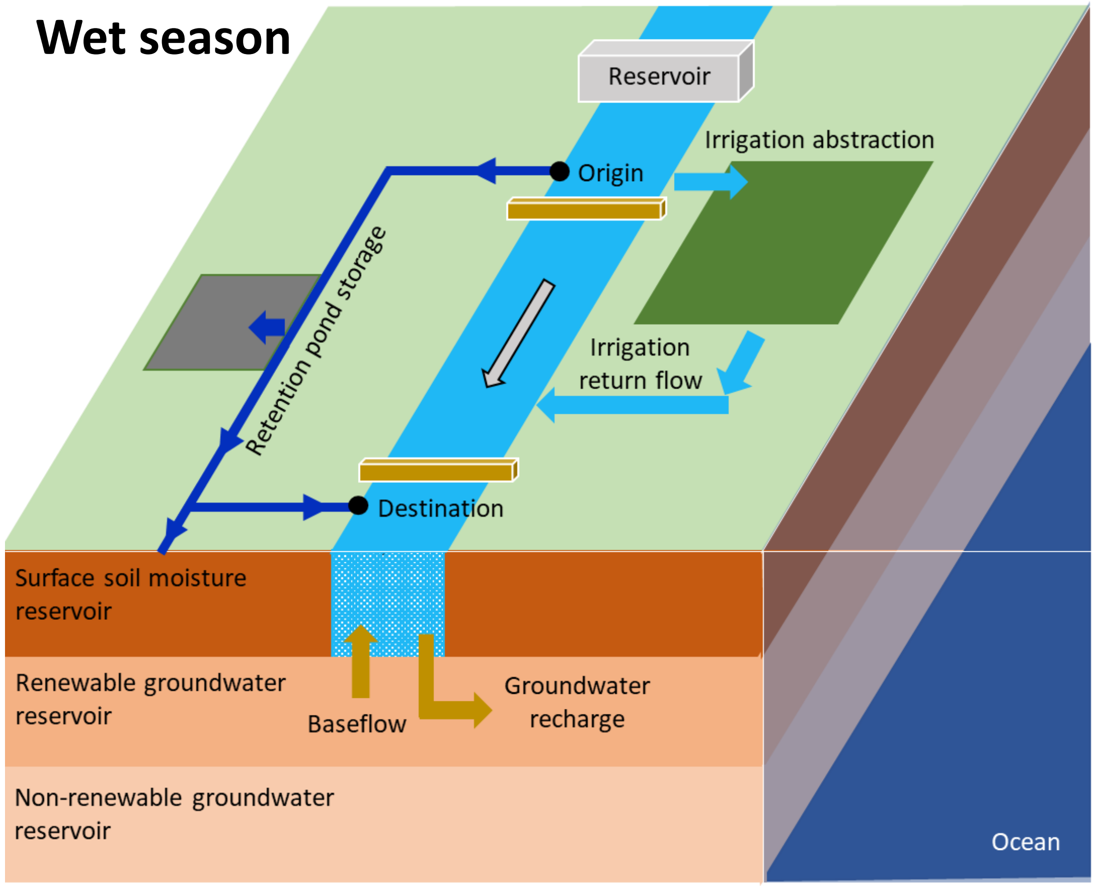
Hanasaki et al. (2018)

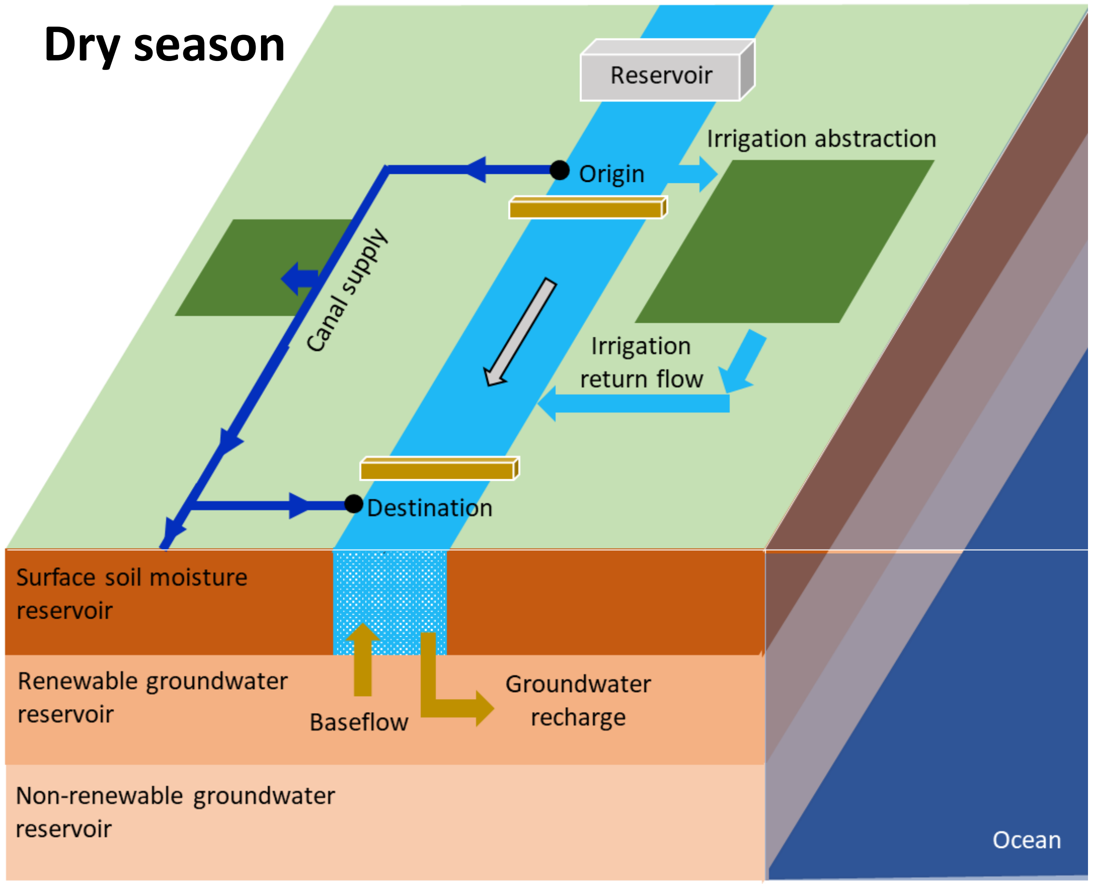


Simulation period

1) Historic simulation from 1980-1999
2) Future simulation from 2080-2099 under RCP 4.5 and 8.5

INCLUSION OF CANAL SYSTEMS INTO THE H08 MODEL





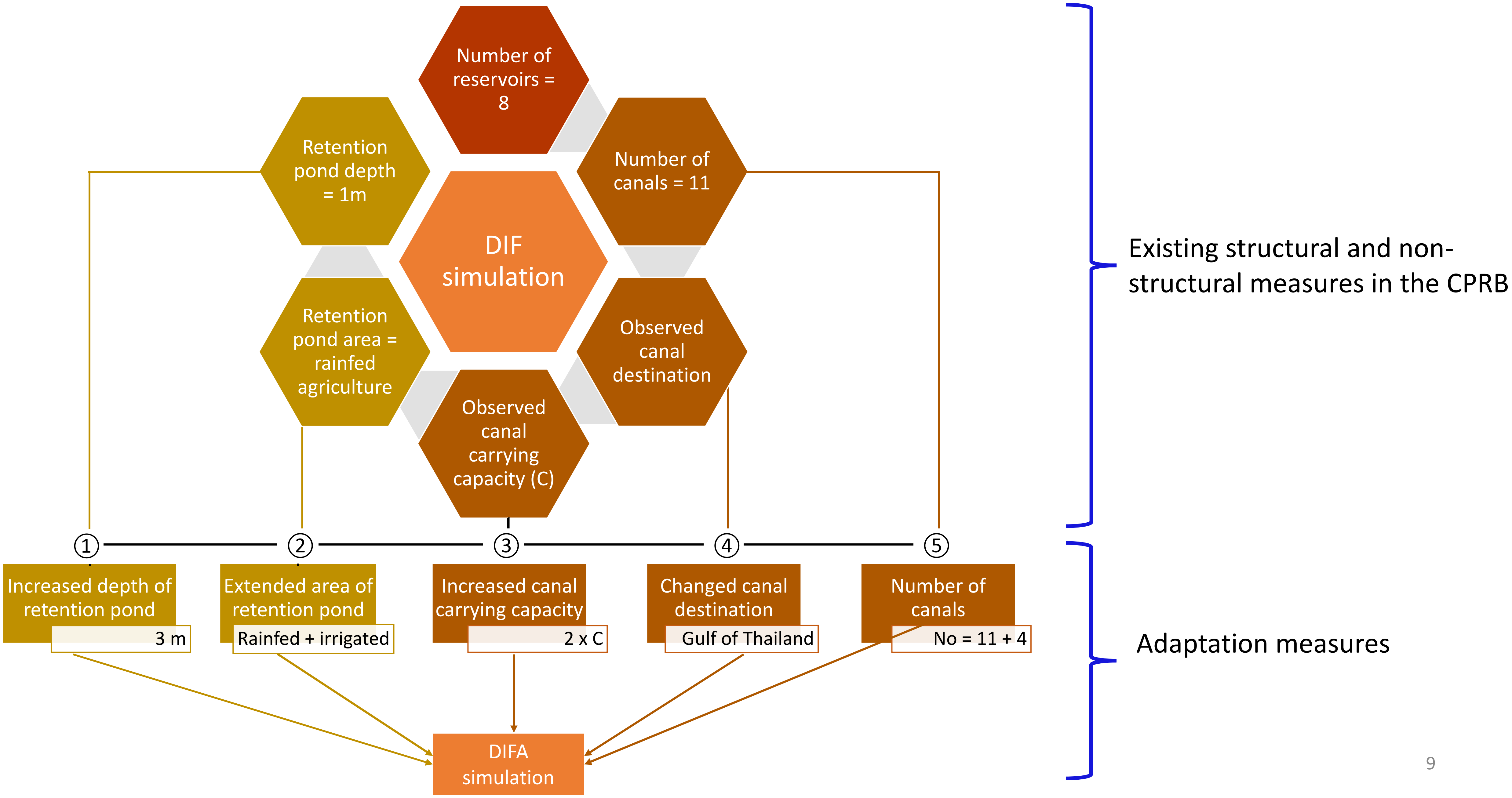
Flood diversion canal ➔ act as flood diversion canal during wet season (May – Dec) with retention ponds

- If Q > river capacity ➔ divert canal capacity
- If Q < river capacity ➔ divert minimum flow

Irrigation canal ➔ act as irrigation canal during the dry season (Jan – April) with supply to local grids

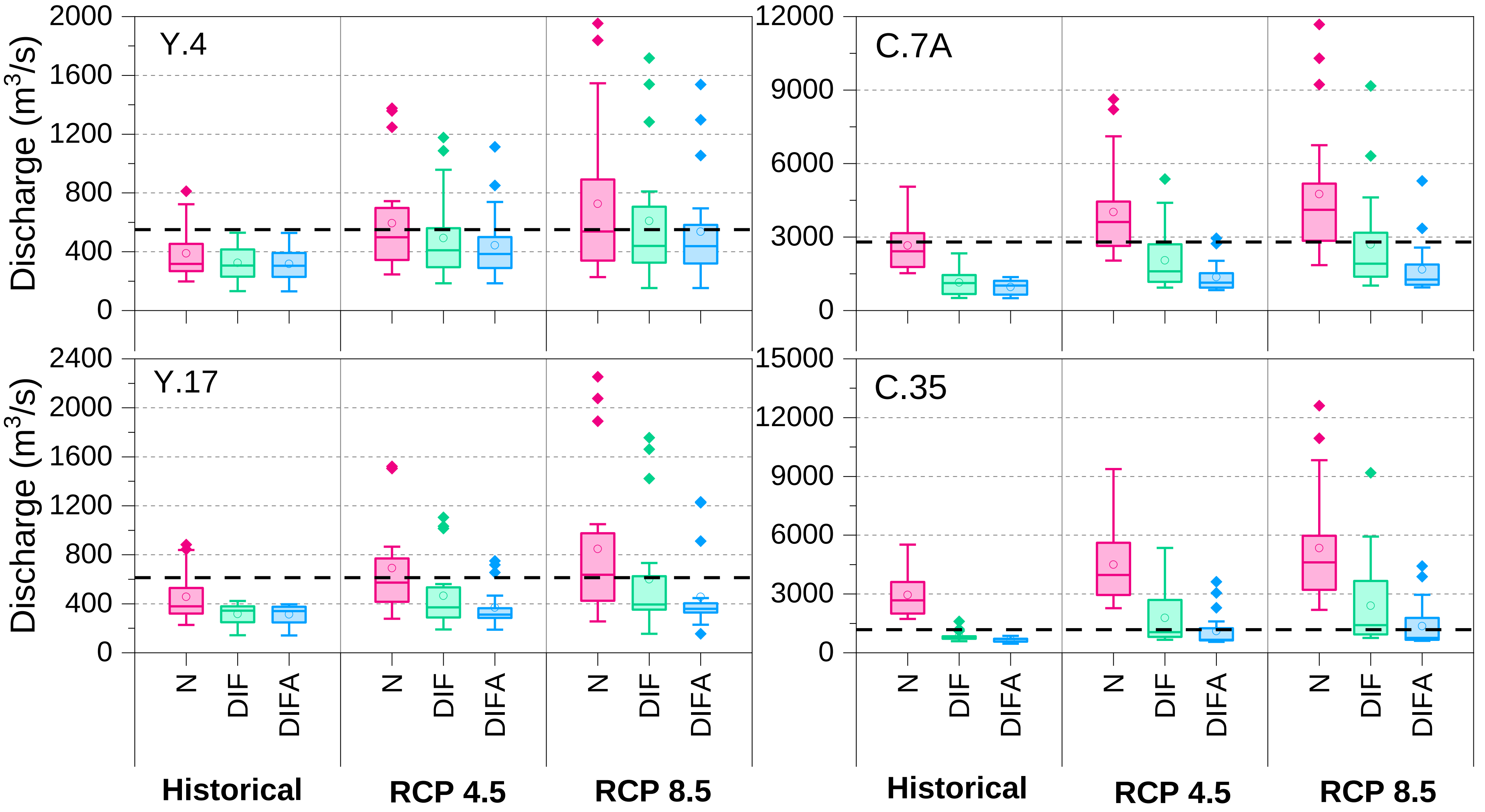
- If Q > environmental flow ➔ divert minimum flow
- If Q < environmental flow ➔ No diversion

Simulations



RESULTS AND DISCUSSIONS

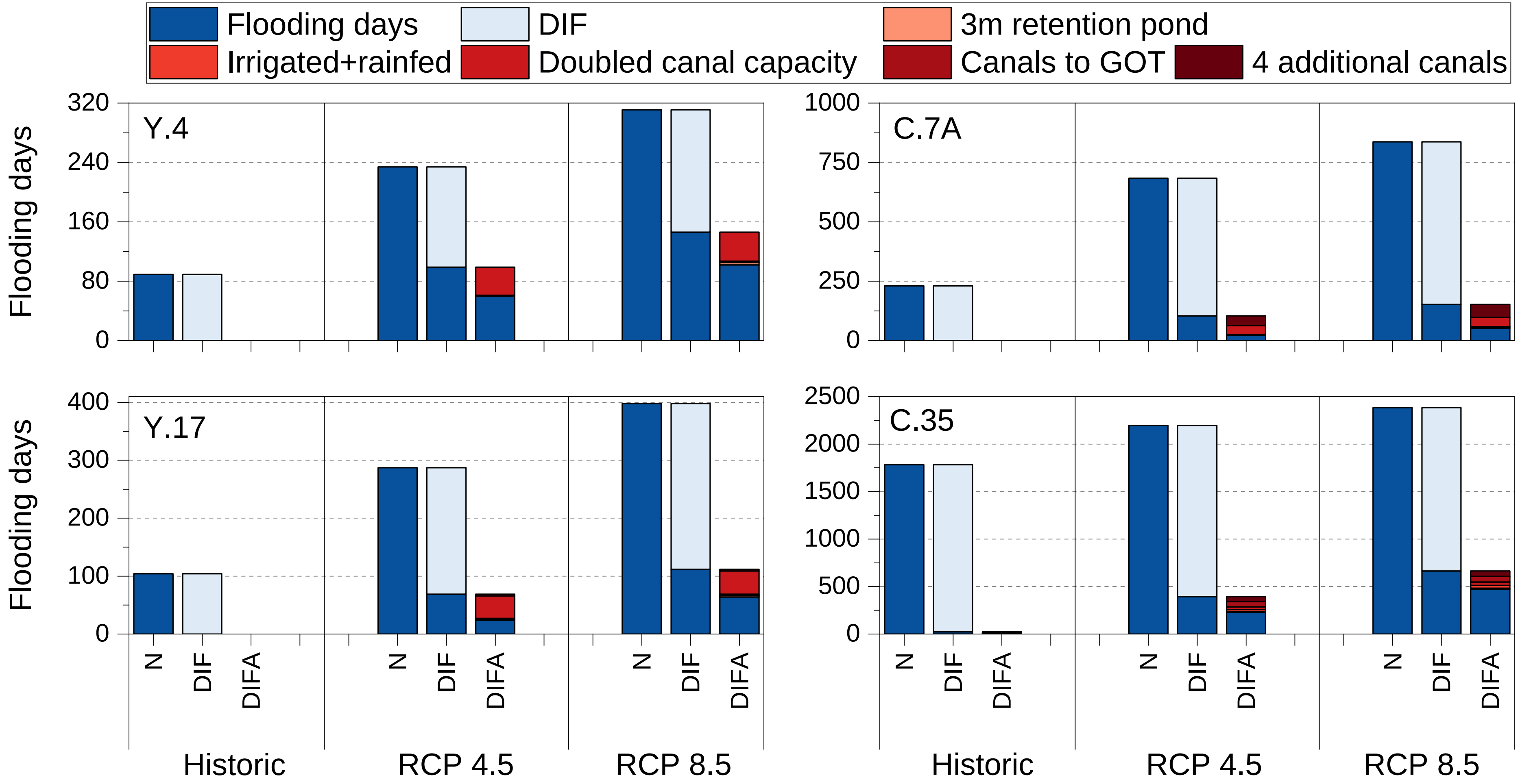
(1) Impact of water infrastructures on annual maximum daily discharge



- Extreme floods cannot be avoided even after implementing the adaptation measures

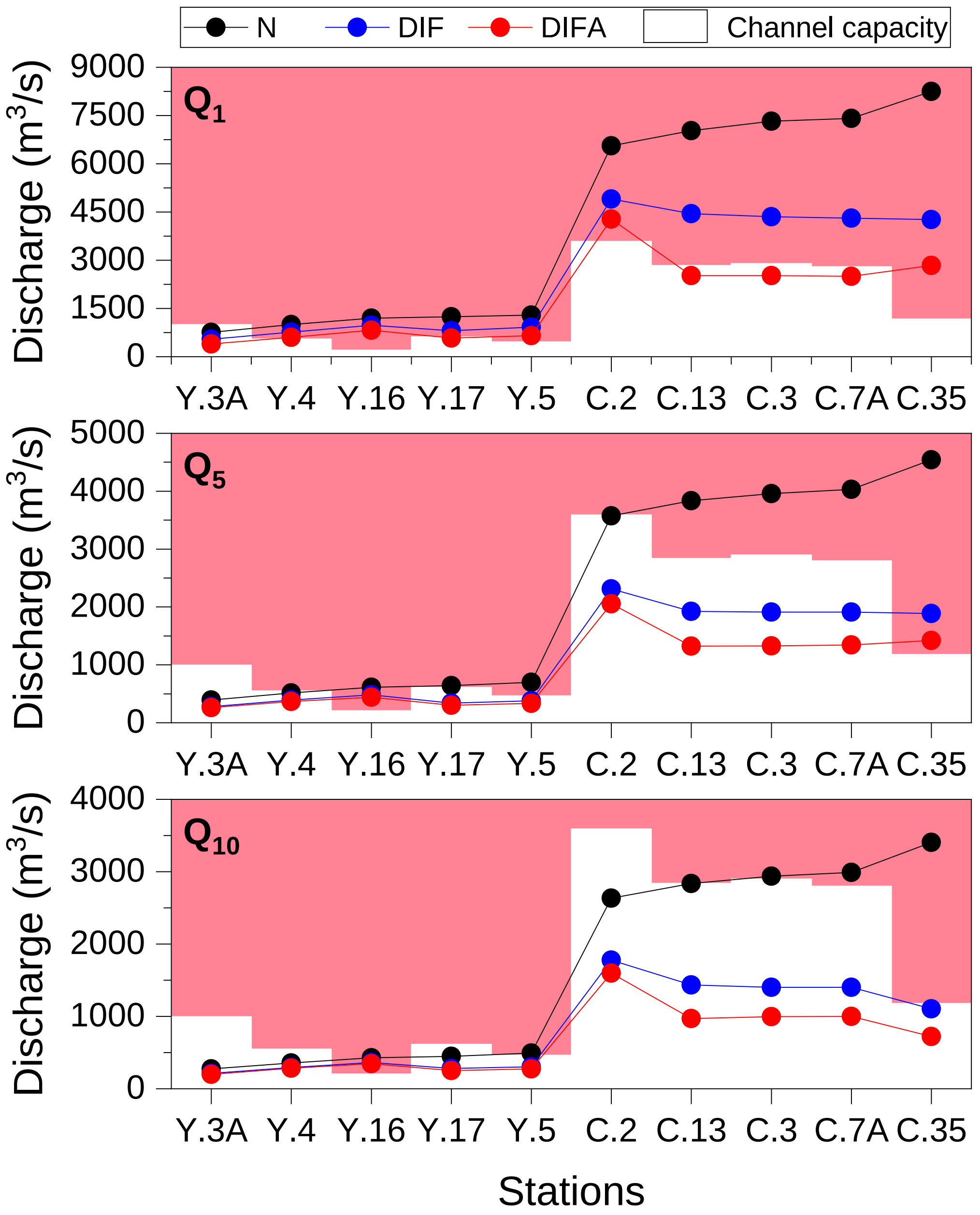
(2) Impact of water infrastructures on number of flooding days

Flooding day → daily flow > channel capacity



- None of these adaptation measures were able to reduce the number of future flooding days close to zero

(3) Impact of water infrastructures on extreme flood flows (RCP 8.5)



- This figure illustrates the impact of water infrastructures on flood frequency under RCP 8.5
- Q1 index ➔
  - There are still flood flows at many stations in the CPRB (Y.4, Y.16, Y.17, Y.5, C.2, and C.35)
- Q5 index ➔
  - Reduced risk of flood in most of the stations except at Y.16 and C.35
- Q10 index ➔
  - The flood risk remains only at Y.16 due to its very low carrying capacity of 207 m^3/s

CONCLUSIONS

- Future flood risk was analyzed using various flood risk indicators including high flows, number of flooding days, and annual maximum daily discharge
- Integration of various existing structural and non-structural measures along with adaptation measures will be insufficient to completely mitigate future flood risk in the CPRB although the considered measures can greatly reduce future flooding
- This study highlights the areas of the CPRB that are vulnerable to extreme flooding in the future and thus require area-based prioritization for flood management
- Moreover, this study clearly indicated that GHMs can be effectively implemented for the design of regional adaptation measures

THANK YOU

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