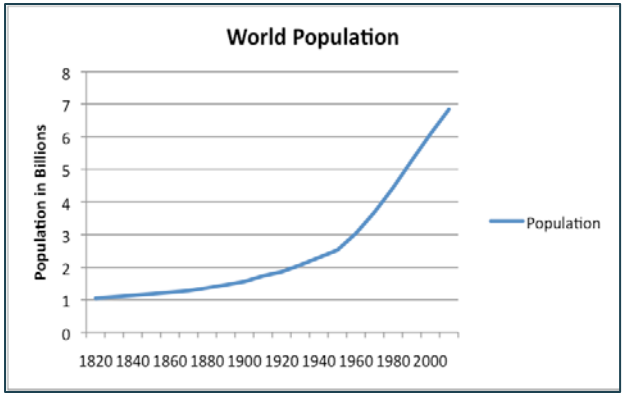
Human impacts on water scarcity in the 20th century

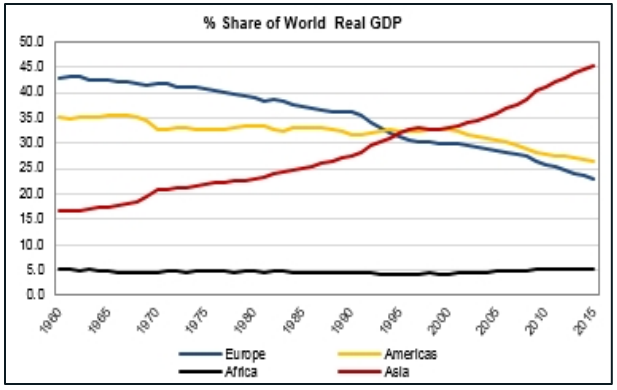
A multi-model and multi-forcing analysis

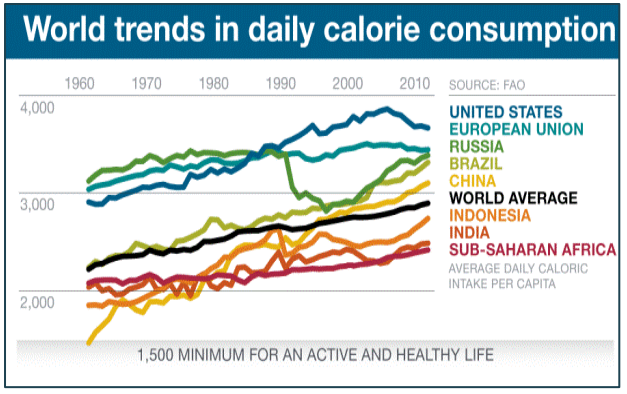
Ted Veldkamp et al.

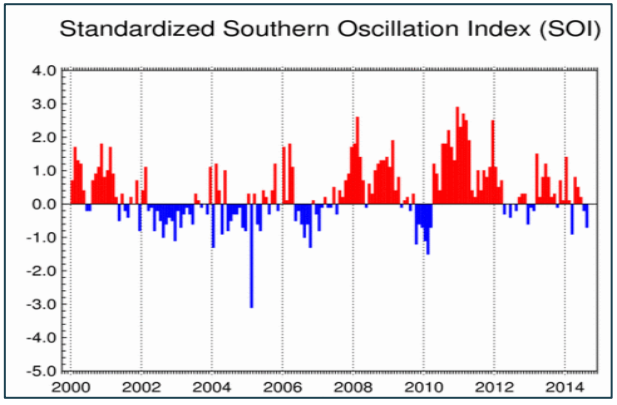
ISI-MIP, June 2016

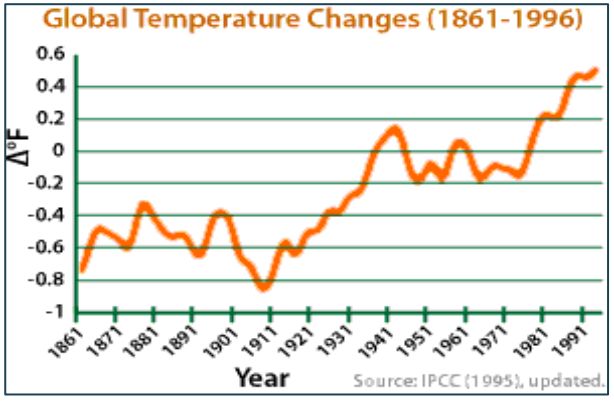
Increasing pressures on World's water resources



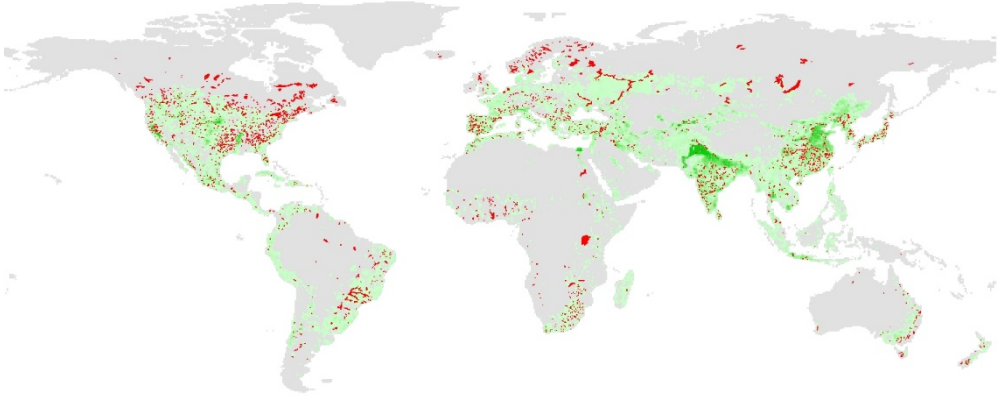


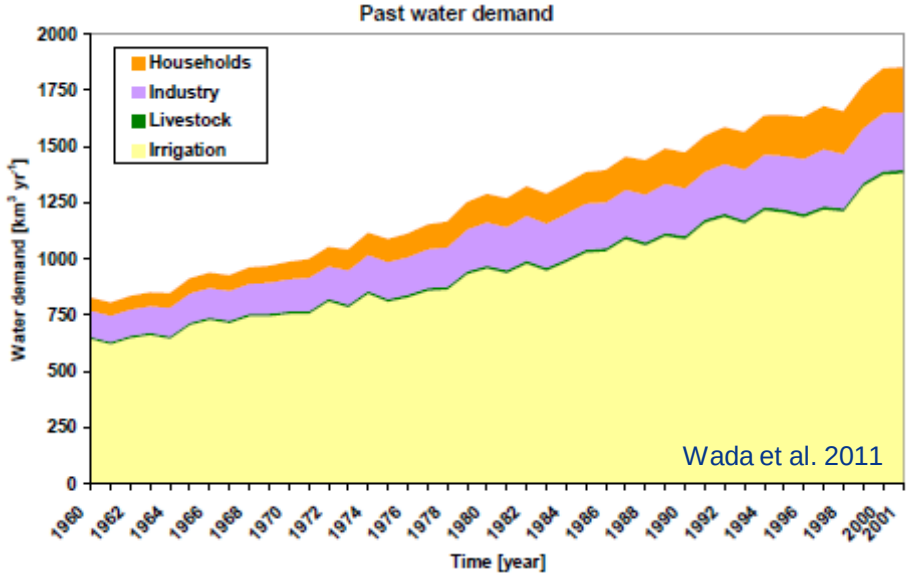






Call for increasing levels of management and use of water





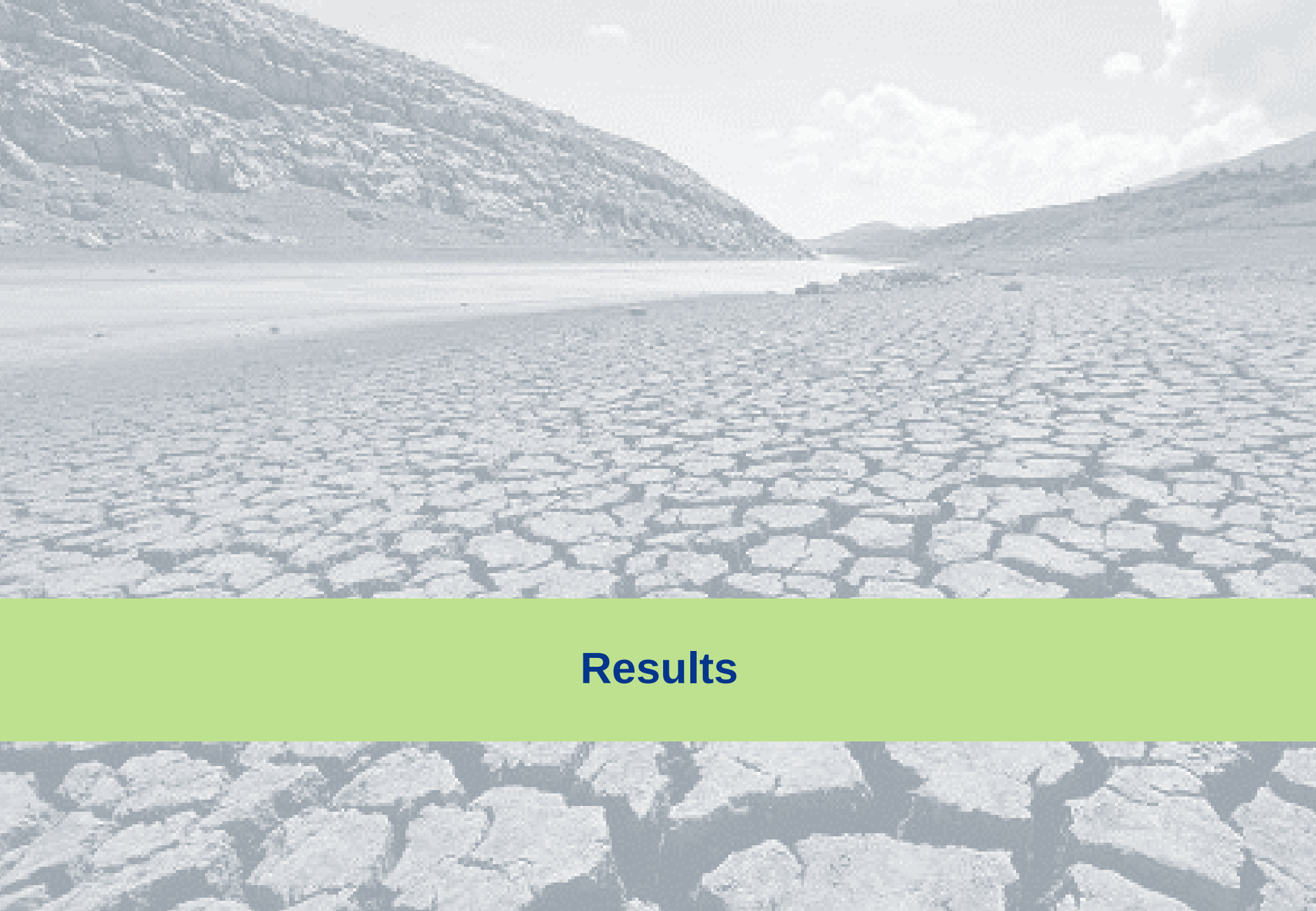
Research questions

What is the impact of time-varying LULCC and human interventions on water resources and water scarcity conditions in the 20th century at a sub-annual scale?

- What is the change in exposure to water scarcity?
- Do LULCC and human interventions influence the seasonality of water scarcity?
- How do other characteristics of water scarcity change: persistence, recurrence?
- What is the source of change: local, local sub-basin, upstream sub-basin

Methods & Data

- Evaluated monthly WA and WS under pristine and transient conditions (1971-2010)
- Water Scarcity Index = [WW / (WA-EF)] WS if WSI > 1
- Monthly variable environmental flow requirements (Pastor 2014)
- Dynamic HYDE 3.1 - MIRCA dataset to cover LULCC
- ISI-MIP 2.1a global water data :
  - 5 impact models: H08, LPJmL, MATSIRO, PCR-GLOBWB, WaterGAP
  - 3 forcing data-sets: GSWP3, WFDEI, Princeton
- Ensemble-statistics: interquartile-range, ensemble-mean, ensemble-median



Results

Exposure to water scarcity – pattern of change WA

Decreasing availability of water resources (Ens-Mean)

Increasing availability of water resources (Ens-Mean)

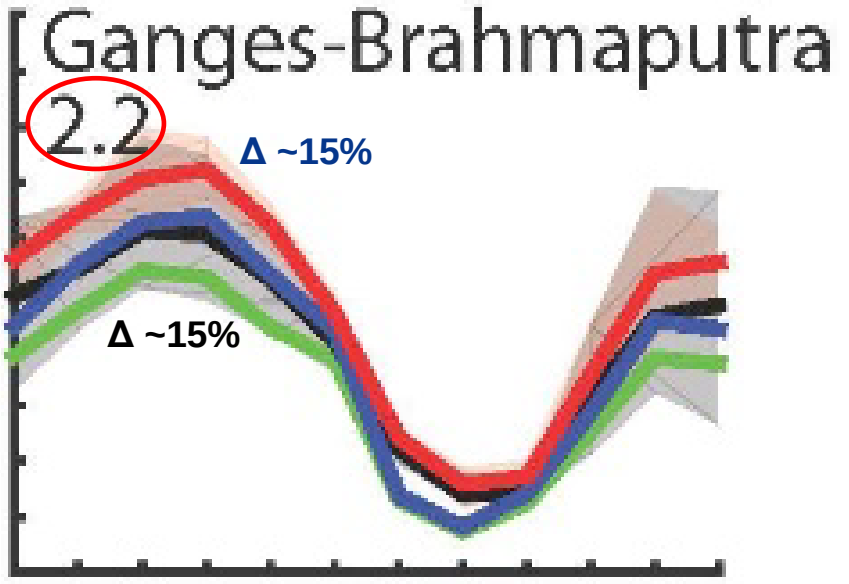
Decreasing availability of water resources (Inter-Quart. range)

Increasing availability of water resources (Inter-Quart. range)

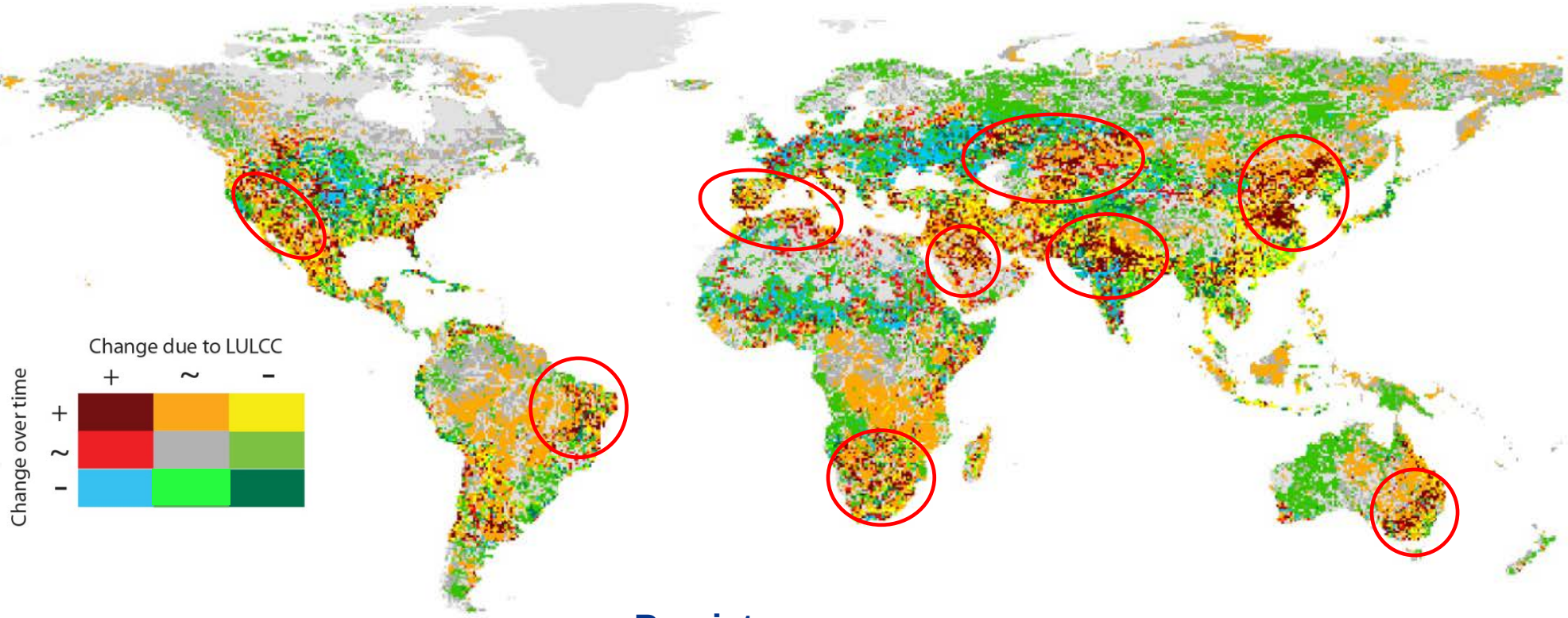
Exposure to water scarcity – pattern of change WS

Movement into/Increasing severity of water scarcity (Ens-Mean)
Movement out/Decreasing severity of water scarcity (Ens-Mean)
Movement into/Increasing severity of water scarcity (Inter-Quart. range)
Movement out/Decreasing severity of water scarcity (Inter-Quart. range)

Exposure to water scarcity – net change



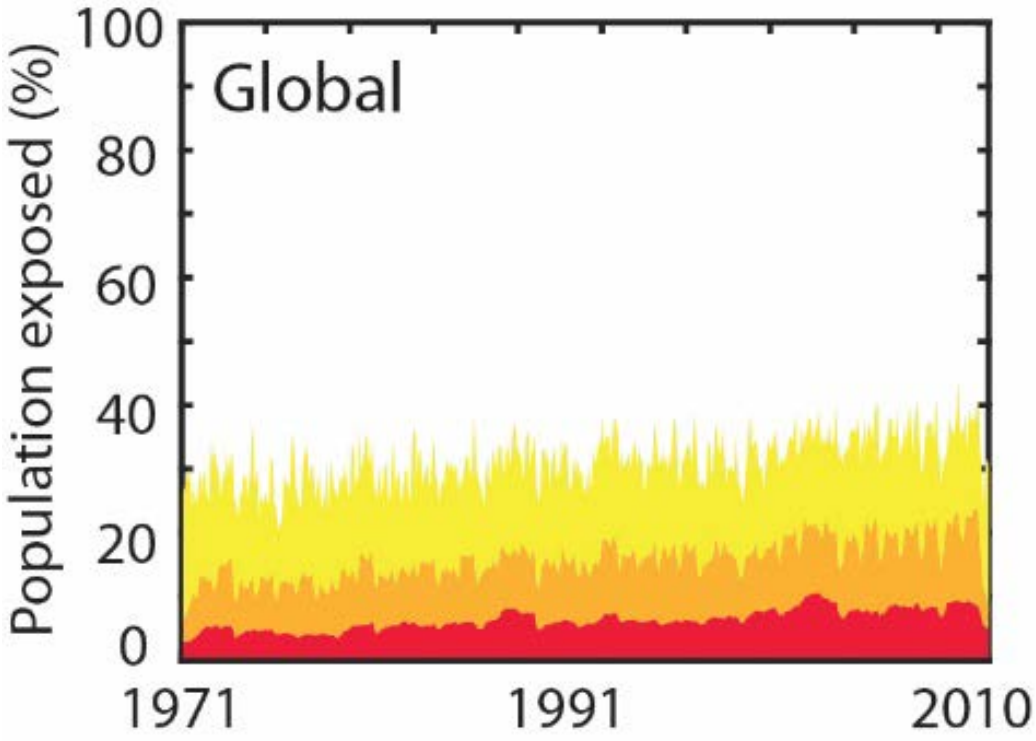
Persistence and recurrence of water scarcity events



Persistence

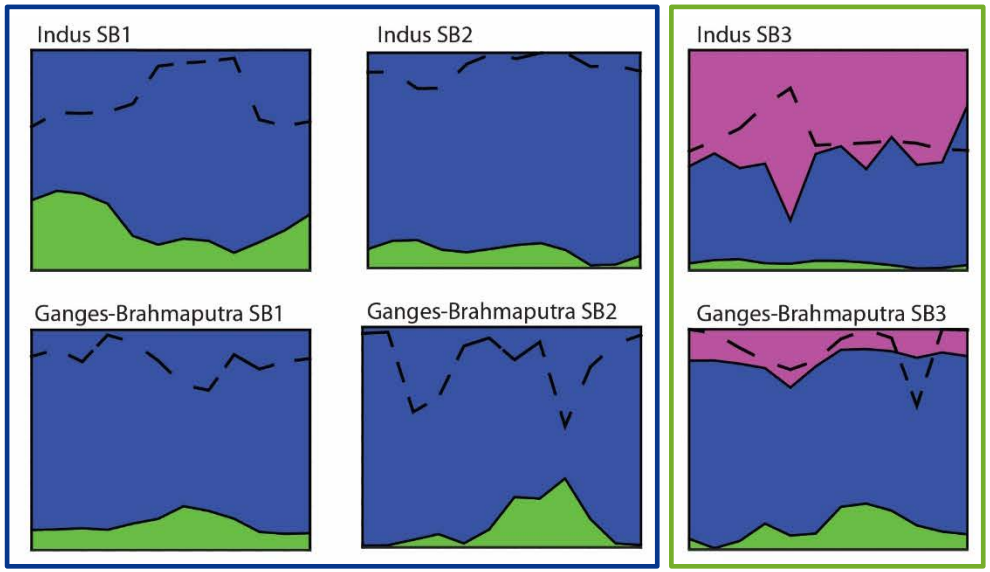
months / # events

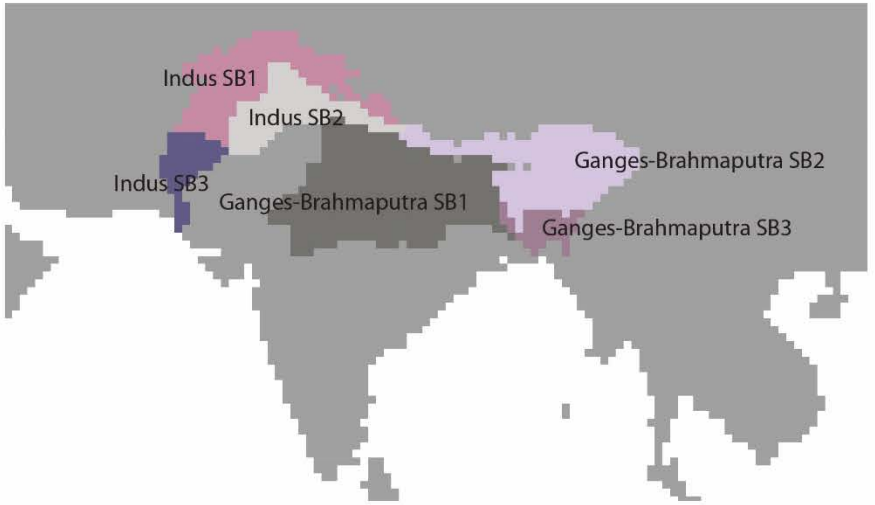
Duration of water scarcity events



Short duration events (< 6m) Medium duration events (6-12m) Long duration events (> 12m)

Drivers of change





Local runoff as largest contributor of increasing water scarcity

Incoming discharge local sub-basin as largest contributor of increasing water scarcity

Incoming discharge upstream sub-basin as largest contributor of increasing water scarcity

Local runoff as largest contributor of decreasing water scarcity

Take home messages

Impacts LULCC & human interventions on water scarcity via a MM framework

- Sub-annual level, minimum environmental flow requirements, multi-model framework

Exposure:

- Higher than yearly estimates, lower than monthly estimates (seasonal approach)
- Significant share of population affected by change in WA and WS
- Net effects minor – especially globally

Seasonality:

- Explicit regional patterns
- Clear impacts of human interventions – especially during ‘high exp.’ seasons
- No seasonal shifts in exposure

Take home messages

Persistence:

- Significant regional variations – persistence & change in persistence
- Significant land area with increasing persistence over time/human interventions
- Increasing exposure to medium/long WS events
- Different WS events illustrative for variability: seasonal, annual, decadal

Drivers of change:

- Increasing WA/Decreasing WS: local runoff
- Decreasing WA/Increasing WS: incoming discharge (local/upstream sub-basins)

→ Need for IRWM in coping with socioeconomic pressures on water resources

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