Global assessment of water policy challenges under uncertainty in water scarcity projections

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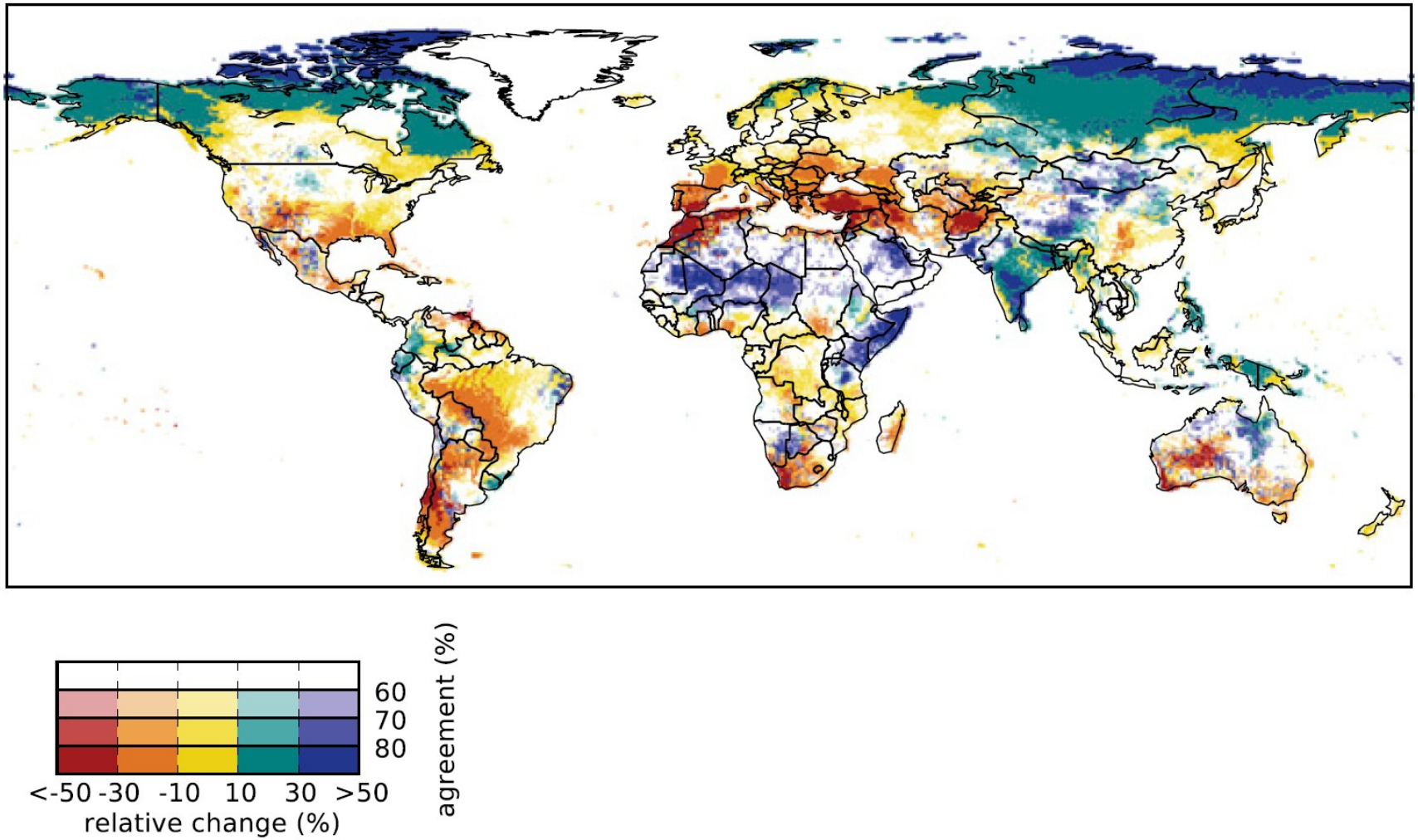
ILEAPS Conference
Mon, 11 Sep

Water scarcity

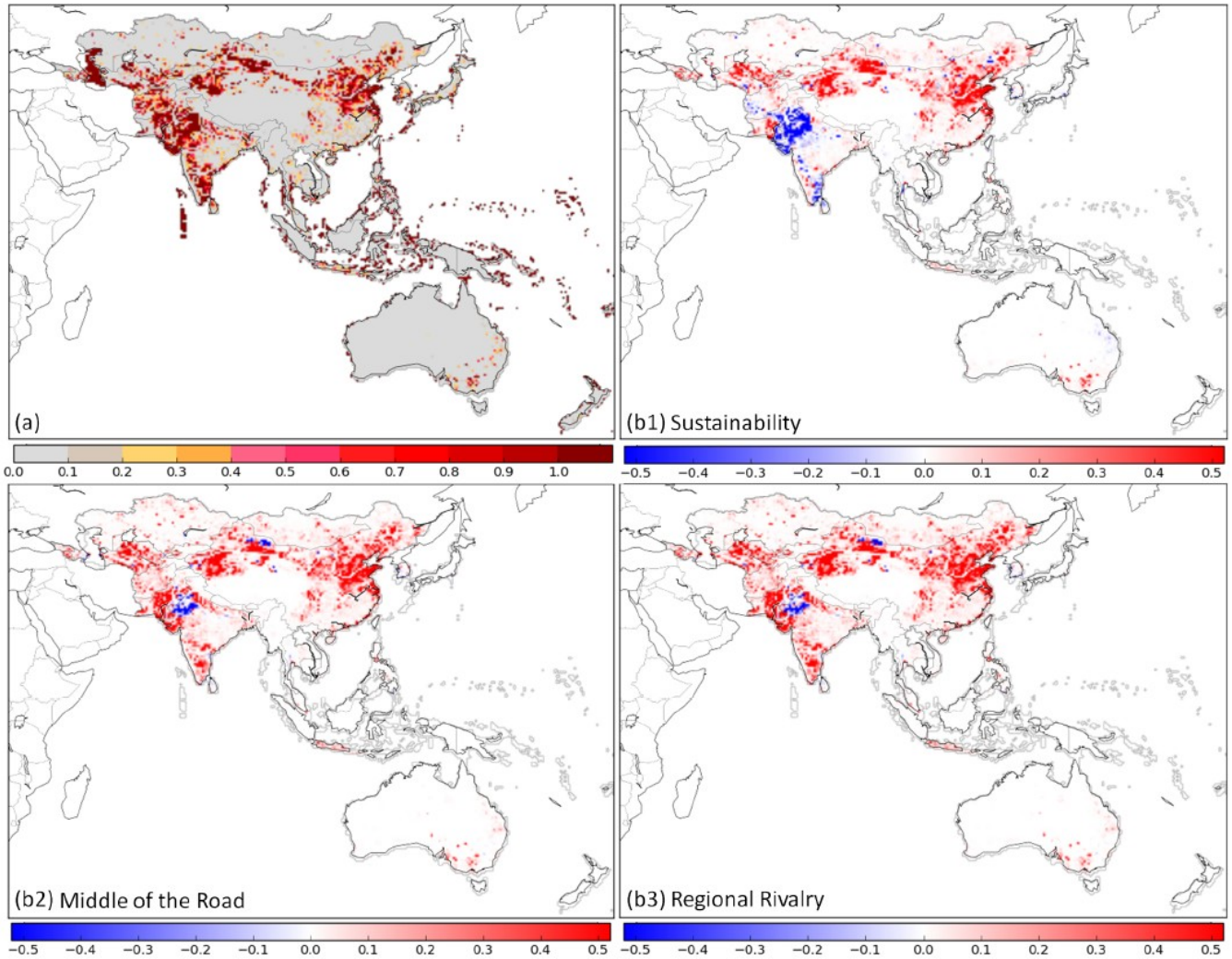
water supply



Schewe et al., PNAS, 2014

Water scarcity

$$\frac{\text{water demand}}{\text{water supply}}$$



Satoh et al., Earth's Future

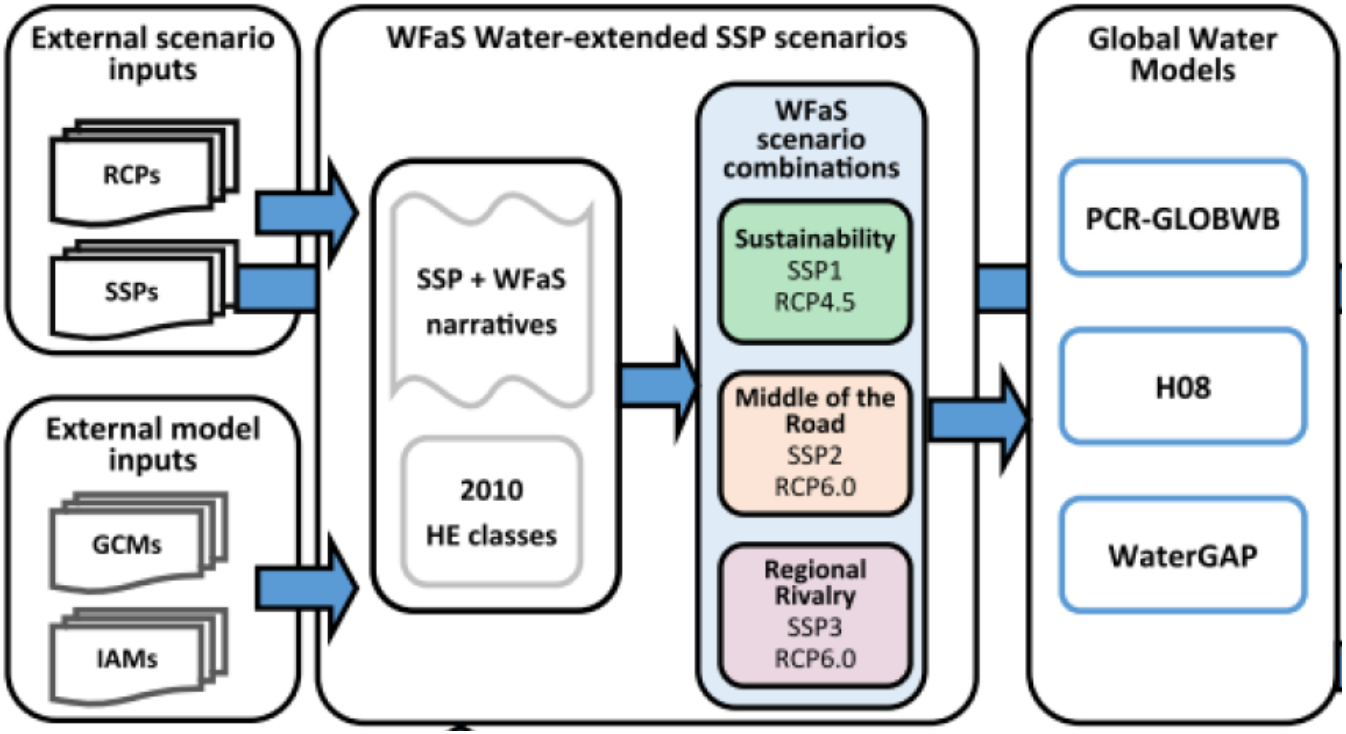
Objectives

Water scarcity is projected to change

- What is the associated **uncertainty**?
- How does this **uncertainty change**?
- What are the most important **sources of uncertainty** (model and scenario uncertainty)?

Resulting policy implications?

Data



Time: 2006-2055

Res: 0.5deg

5 Global Climate Models (GCMs) to force

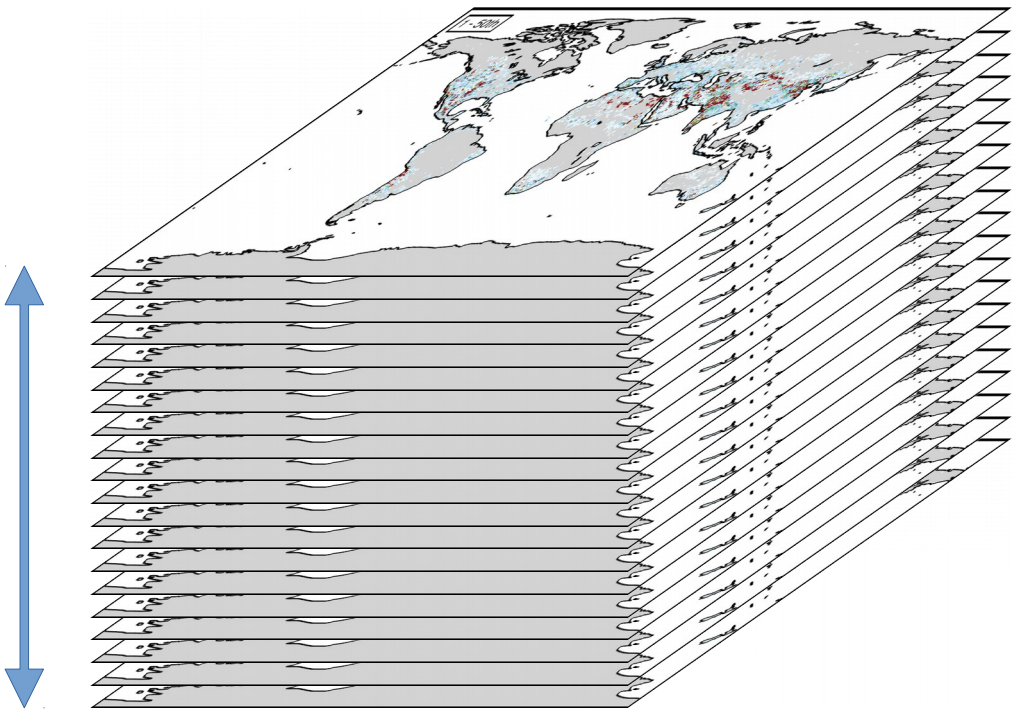
3 Global Hydrological Models (GHMs) under

3 different water scenarios provide global estimates of

water supply and water demand → **water scarcity (dem/sup)**

Data

45 global estimates of projected water scarcity



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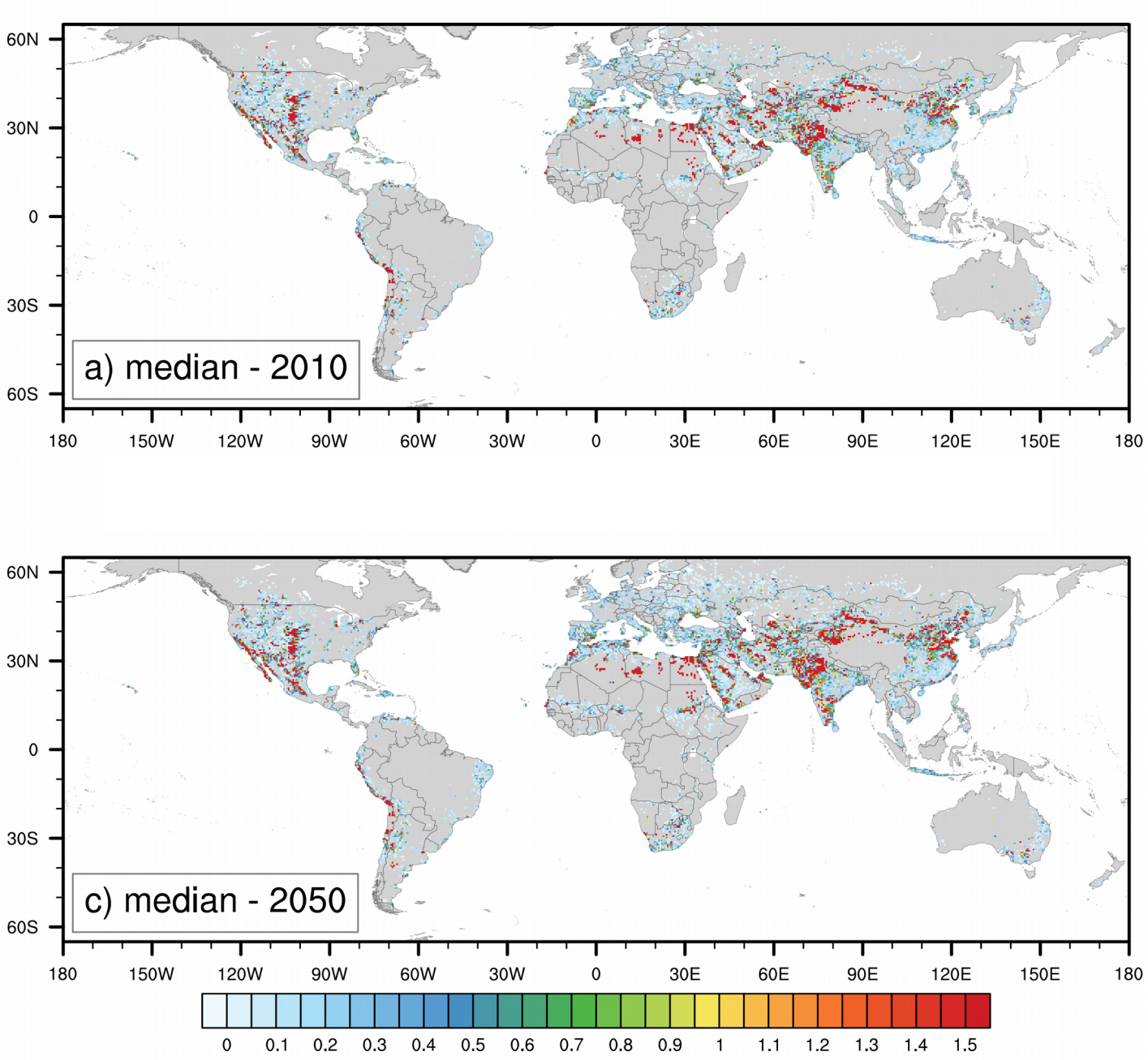
Water scarcity projections



dem/sup > 0.1

median water scarcity

2006-2015

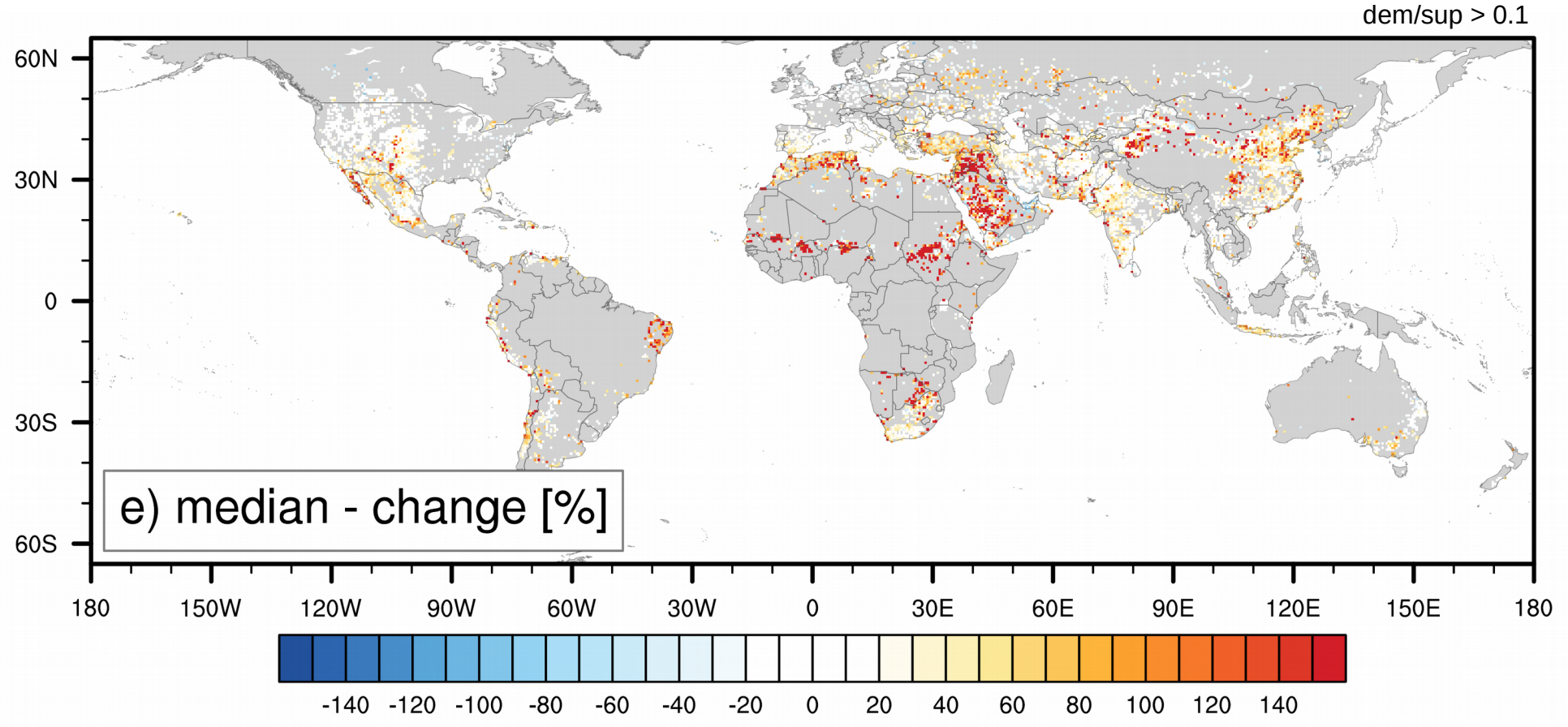
median water scarcity

2046-2055

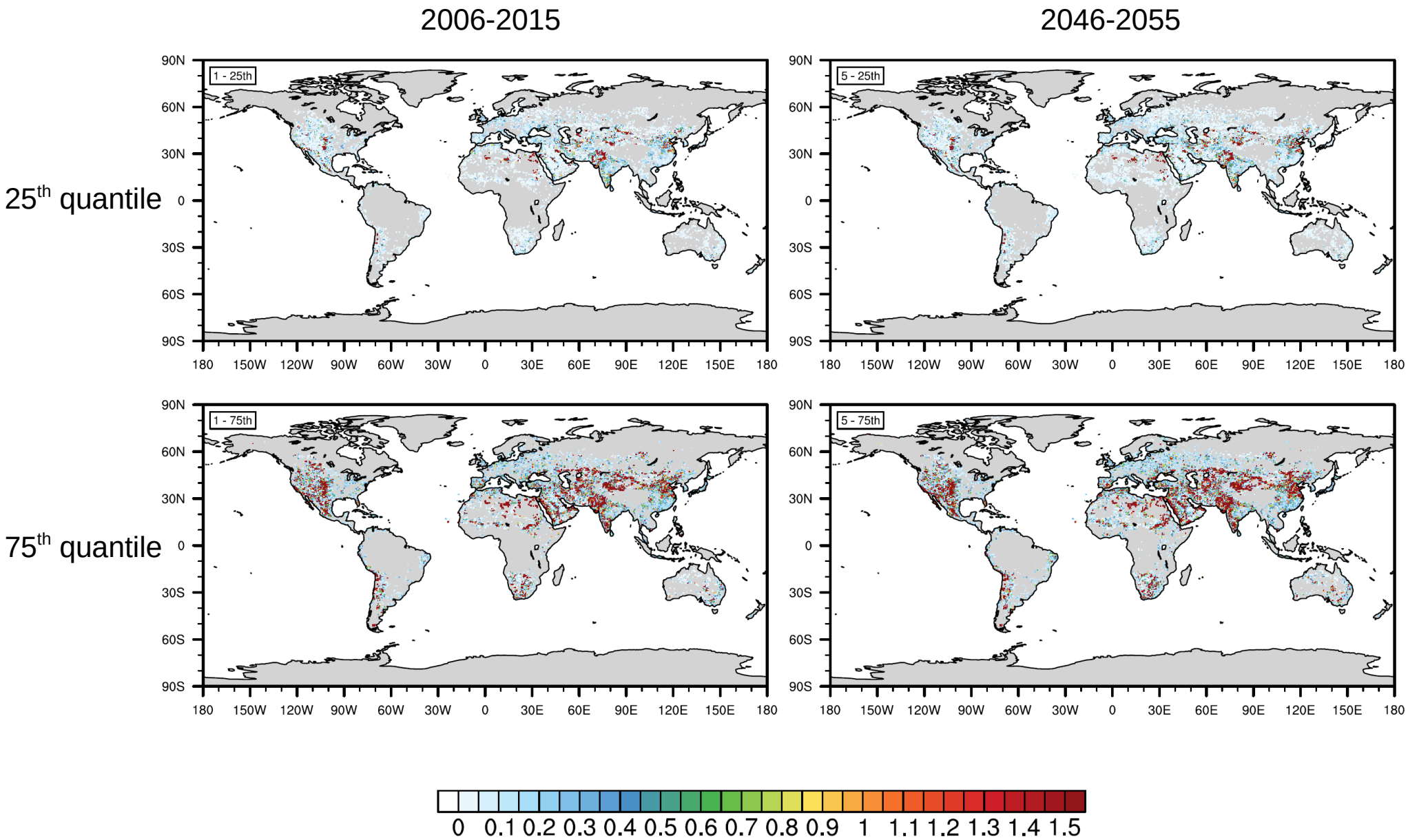
Water scarcity projections

median water scarcity

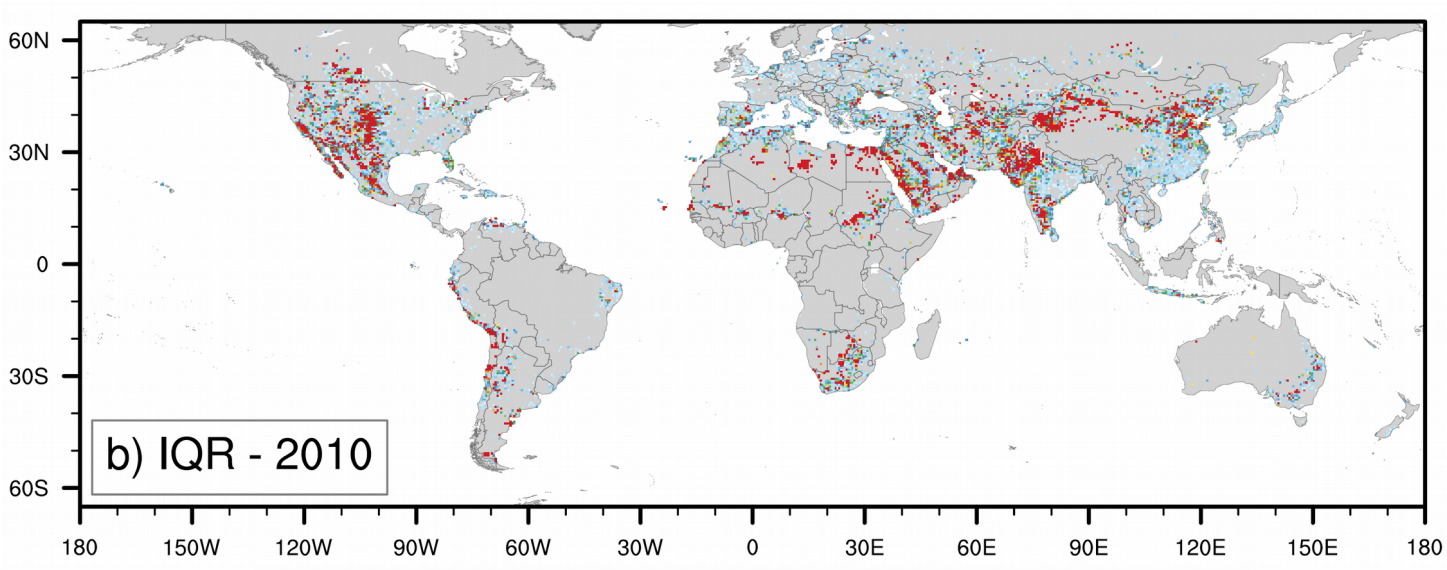
Change
2006-2015 to 2046-2055



Uncertainty in water scarcity projections

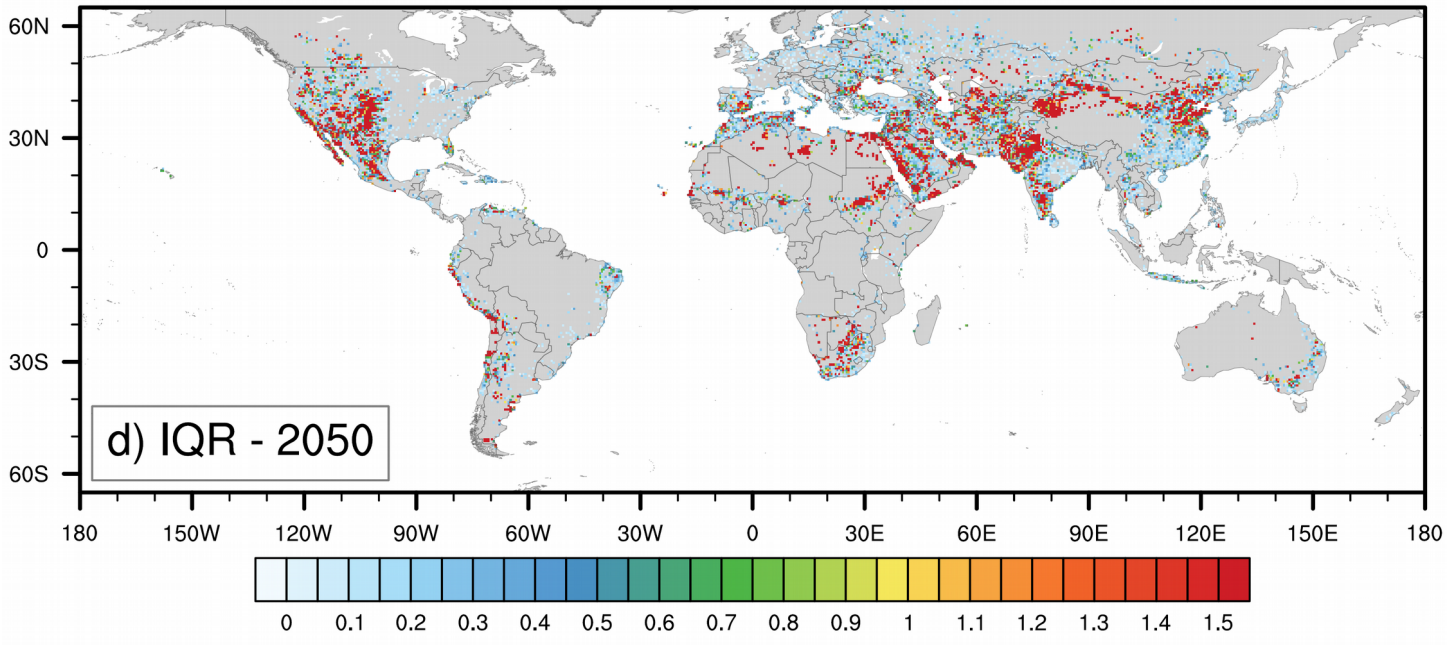


Water scarcity projections



water scarcity IQR

2006-2015



dem/sup > 0.1

water scarcity IQR

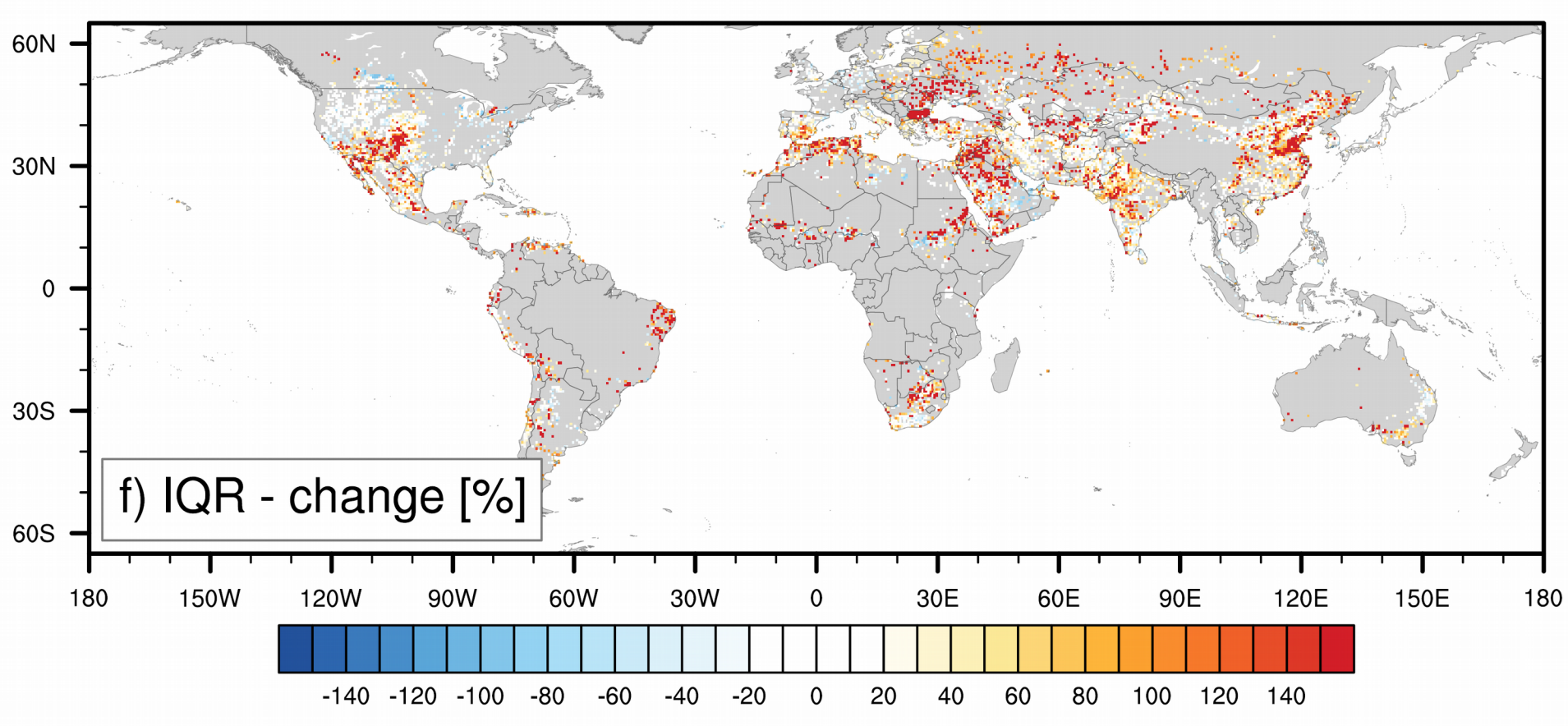
2046-2055

Water scarcity projections

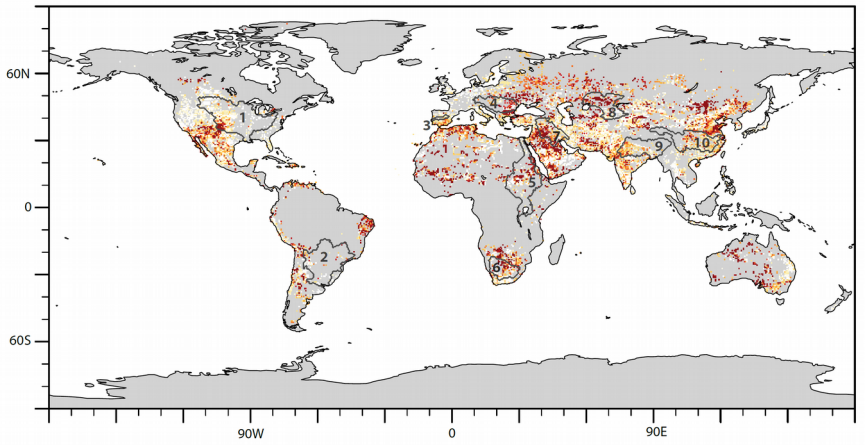
water scarcity IQR

Change
2006-2015 to 2046-2055

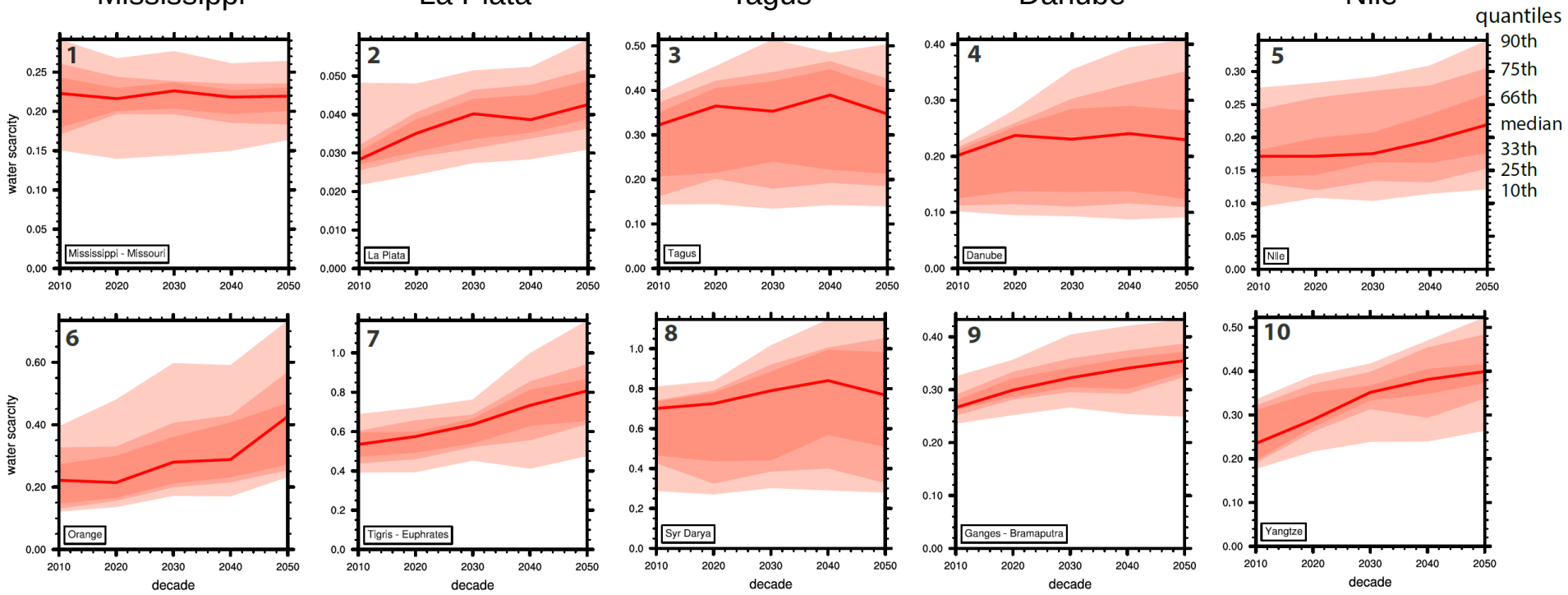
dem/sup > 0.1



Changes in uncertainty

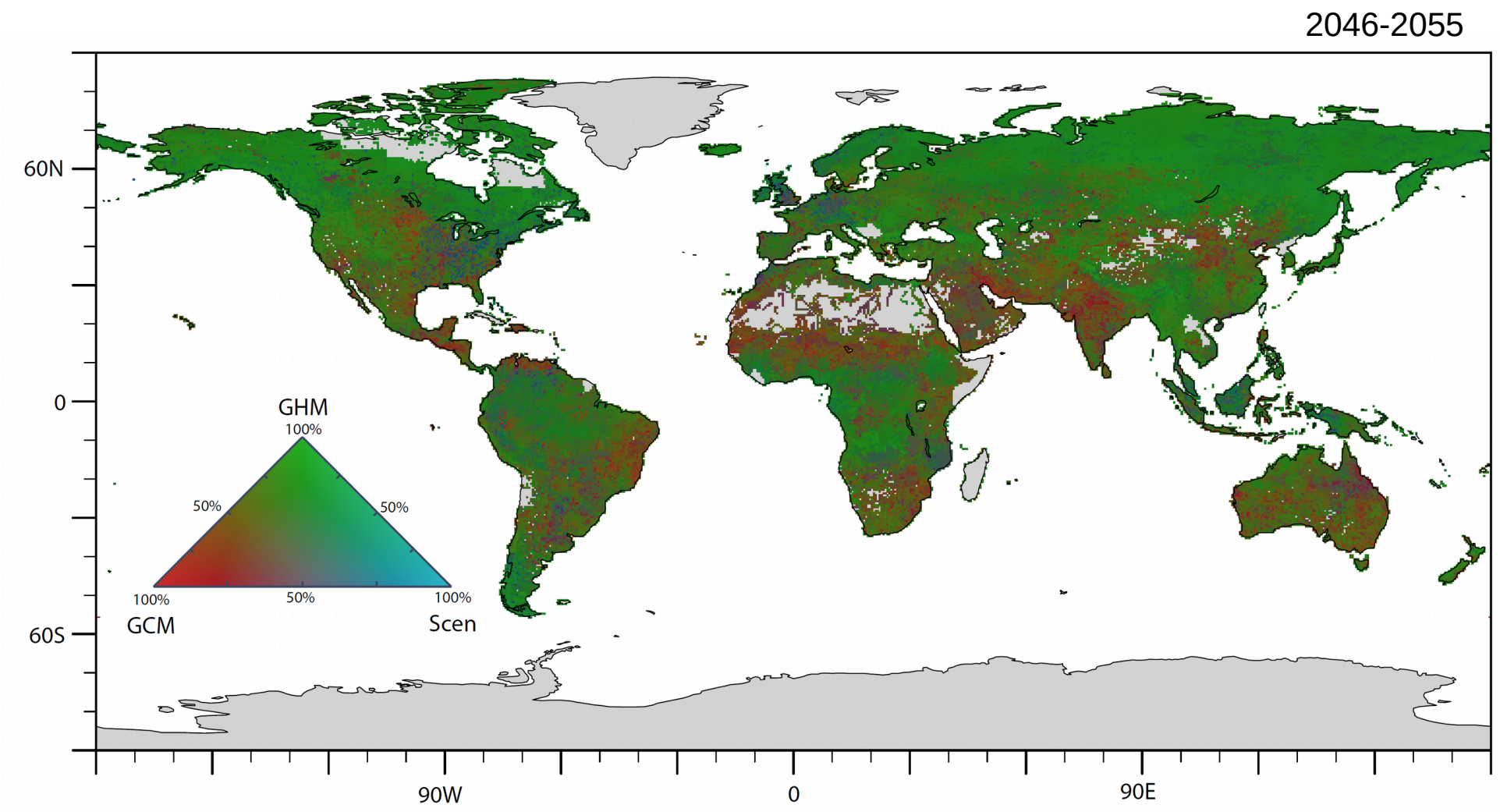


Mississippi | La Plata | Tagus | Danube | Nile



Orange | Tigris-Euphrates | Syr Darya | Ganges-Bramaputra | Yangtze

Sources of uncertainty



- **Global Hydrological Models (GHM)** are the main source of uncertainty in most regions
- **Climate Models (GCM)** are the main driver of uncertainty in many subtropical regions
- Uncertainty stemming from **water scenarios (Scen)** is less important

Objectives

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- What is the associated **uncertainty**?
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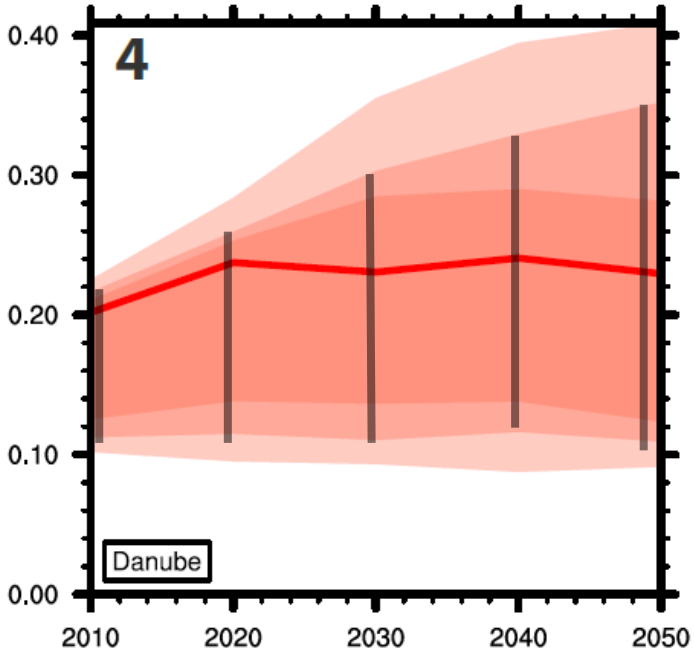
Resulting policy implications?

Clustering

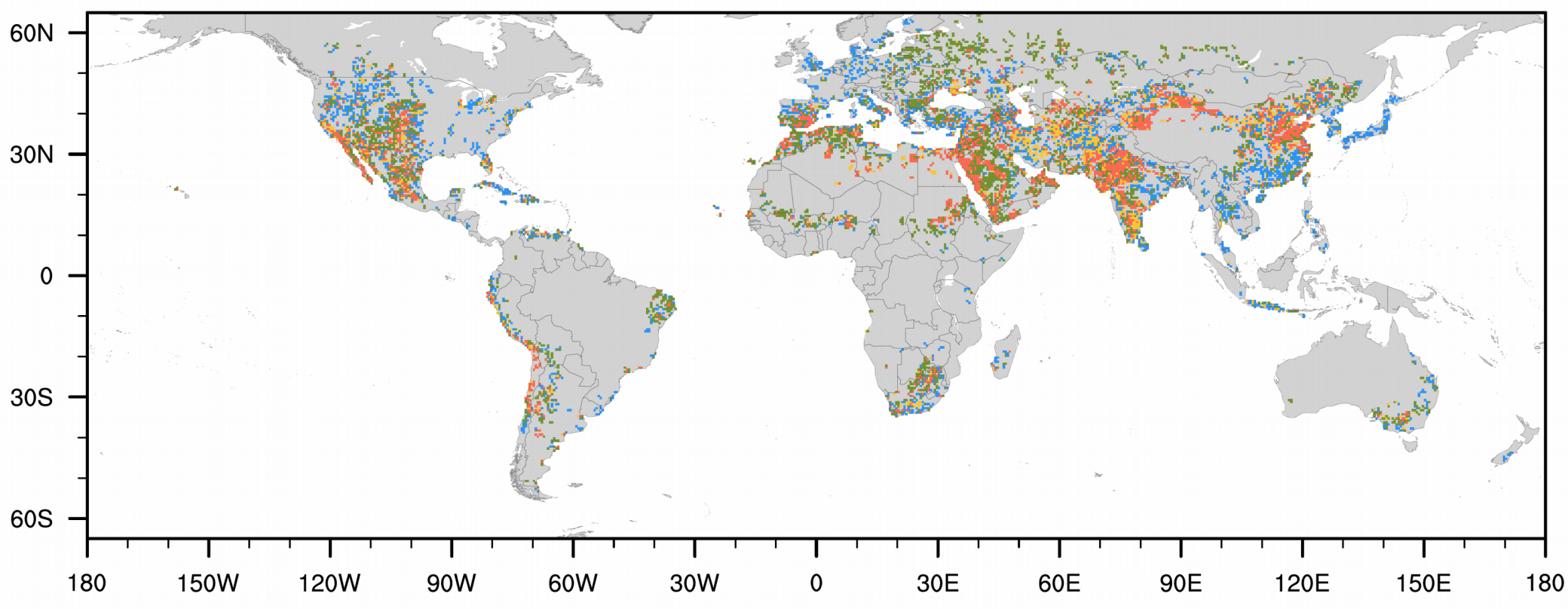
Identify regions of similar changes in uncertainty

Characteristics:
(at every gridpoint)

(i) initial IQR
(ii) decade-to-decade changes in IQR

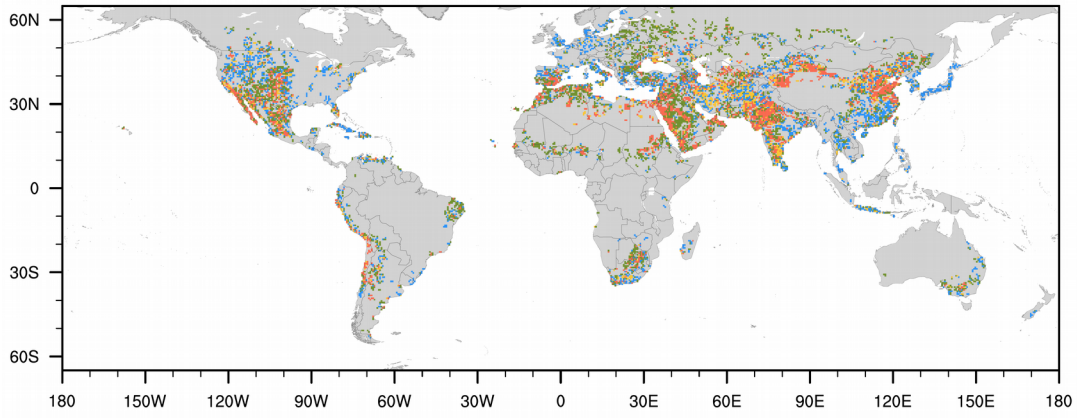


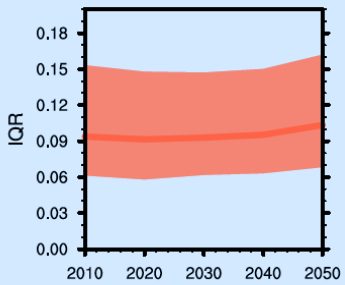
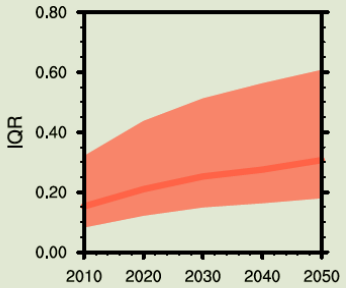
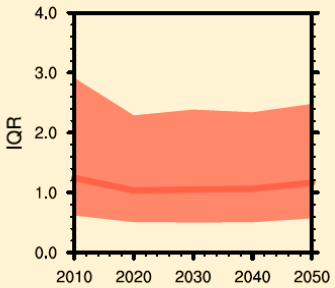
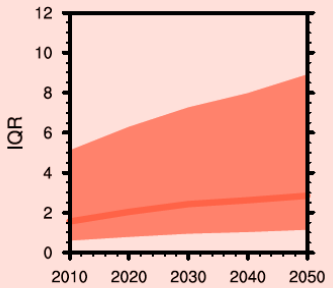
Clustering



Challenges

Clustering



Challenges	low	medium	medium	high
median **water scarcity** (in 2050)	< 0.4 non-, slightly water scarce	< 0.4 non-, slightly water scarce	> 0.4 severely water scarce	> 0.4 severely water scarce
within-area **range of uncertainty** (2010-50)				
uncertainty (2010)	low IQR < 0.15	low to medium IQR < 0.35	medium to high IQR > 0.6	medium to high IQR > 0.6
uncertainty changes (2010-50)	relatively stable	medium to high increase	relatively stable	medium to high increase

Generic policy implications

- **Low challenge areas** (no/limited water scarcity, low & stable uncertainty)
  - no immediate actions required - regular monitoring activities and risk reevaluations are advised

- **Medium challenge areas** (no/limited water scarcity, low & increasing uncertainty)
  - **immediate actions may be advisable - transitional changes will likely suffice**
  - start from implementing **low or no-regret (soft path) transitional options** (beneficial in any case)
  - Implications for farming practice: pressurized systems (sprinklers and drips) instead of surface irrigation, improved crop water productivity (new cultivars), soil management and irrigation scheduling
  - adequate monitoring and early warning systems, diversification of agricultural production, use of crop insurance and compensation schemes

- **Medium challenge areas** (medium/high water scarcity, medium/ high & rel. stable uncertainty)
  - **immediate actions are necessary - transformational changes (hard path) might be necessary**
  - investments in **large water infrastructure** (dams, water transfer, water recycling and reuse, desalination)
  - Broad water management reforms (water buyback – Murray-Darling Basin, efficient wastewater management, rainwater harvesting, etc. - Singapur)

- **High challenge areas** (medium/high water scarcity, medium/high & increasing uncertainty)
  - **immediate actions are necessary - need for transformational changes**
  - investments in **large water infrastructure** (dams, water transfer, water recycling and reuse, desalination) - **modular options that allow for additions and reversals**
  - **Relocation** of industries, development of **alternative livelihoods**
  - risk-reduction strategies and dynamic adaptive policies - flexible water allocation and management rules, clear water use rights and priorities, water exchange in local water markets, virtual water trade in global food markets

Generic policy implications

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    modular options that allow for additions and reversals
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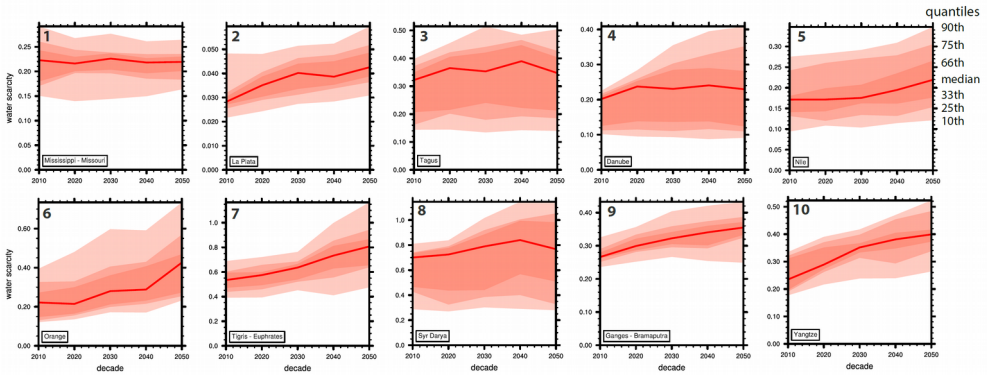
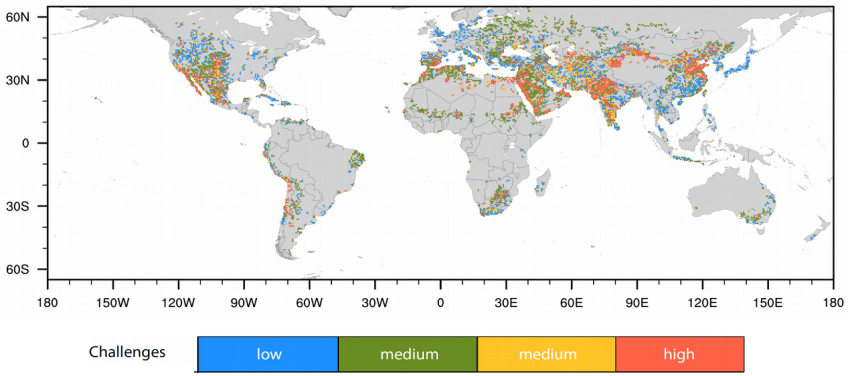
- Implementation of these policies is challenged by governance structure and socio-political barriers.

- Successful adaptation requires:
  - robust institutional infrastructure
  - enhanced local institutional capacities
  - functioning rules
  - improved water governance

Concluding remarks

Assessing both changes in **average water scarcity** and the **associated uncertainties** in model projections.





Adequate policy-making should **recognize** implications arising from **large uncertainties** in future projections.

Evaluating **alternative scenarios** beyond the average projection helps avoid **maladaptation, adverse path dependencies** and **large costs of error.**

Our results call for a **careful and deliberative design of water policy interventions**, especially in the medium-to-high challenge areas identified

Thanks!

Peter Greve

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