Utrecht University

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Clean water scarcity under climate and socio-economic change

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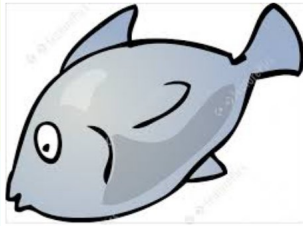
What is ‘water scarcity’?

- *“The demand for water by all sectors and the environment cannot be fully satisfied due to the impact of water use on supply or quality of water” (Liu et al, 2017).*

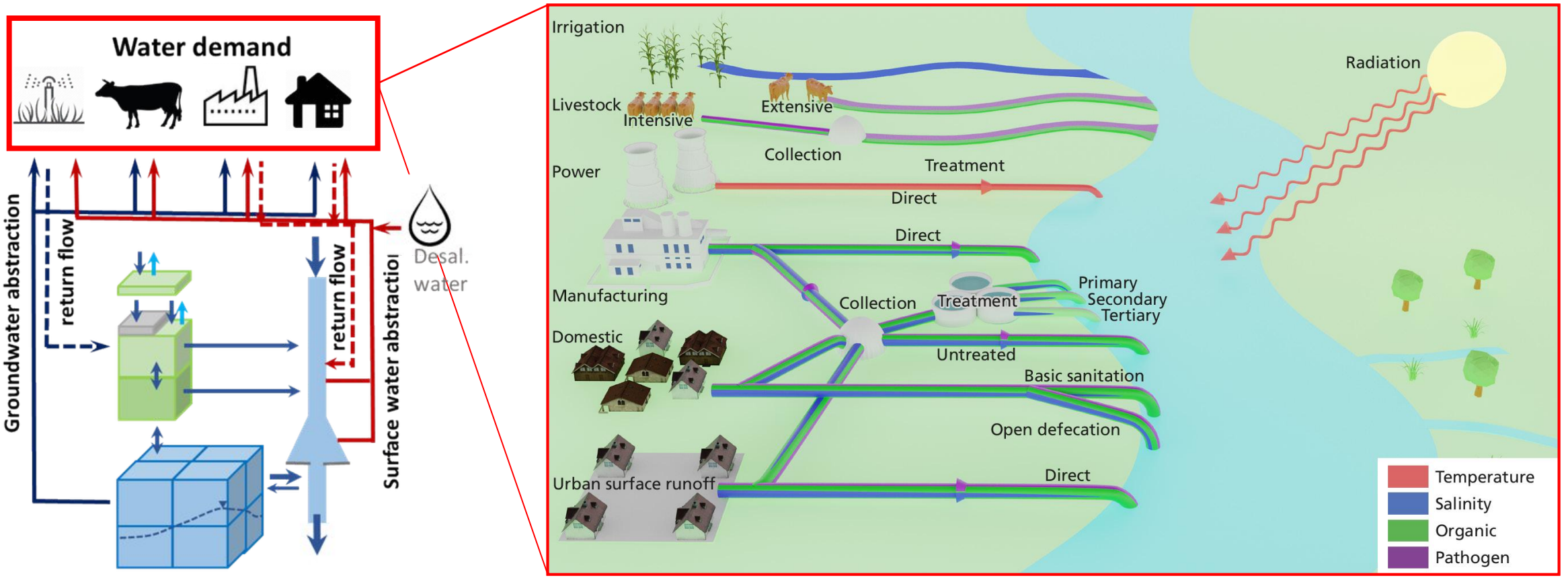
- *Global hydrological models (GHMs) increasingly used to estimate water scarcity*



Source: Water and sanitation program, 2016

Global water quantity and quality modelling

- Global hydrological model: *PCR-GLOBWB2* (Sutanudjaja et al., 2018)
- Fully integrates water use (sectoral water withdrawals and return flows)

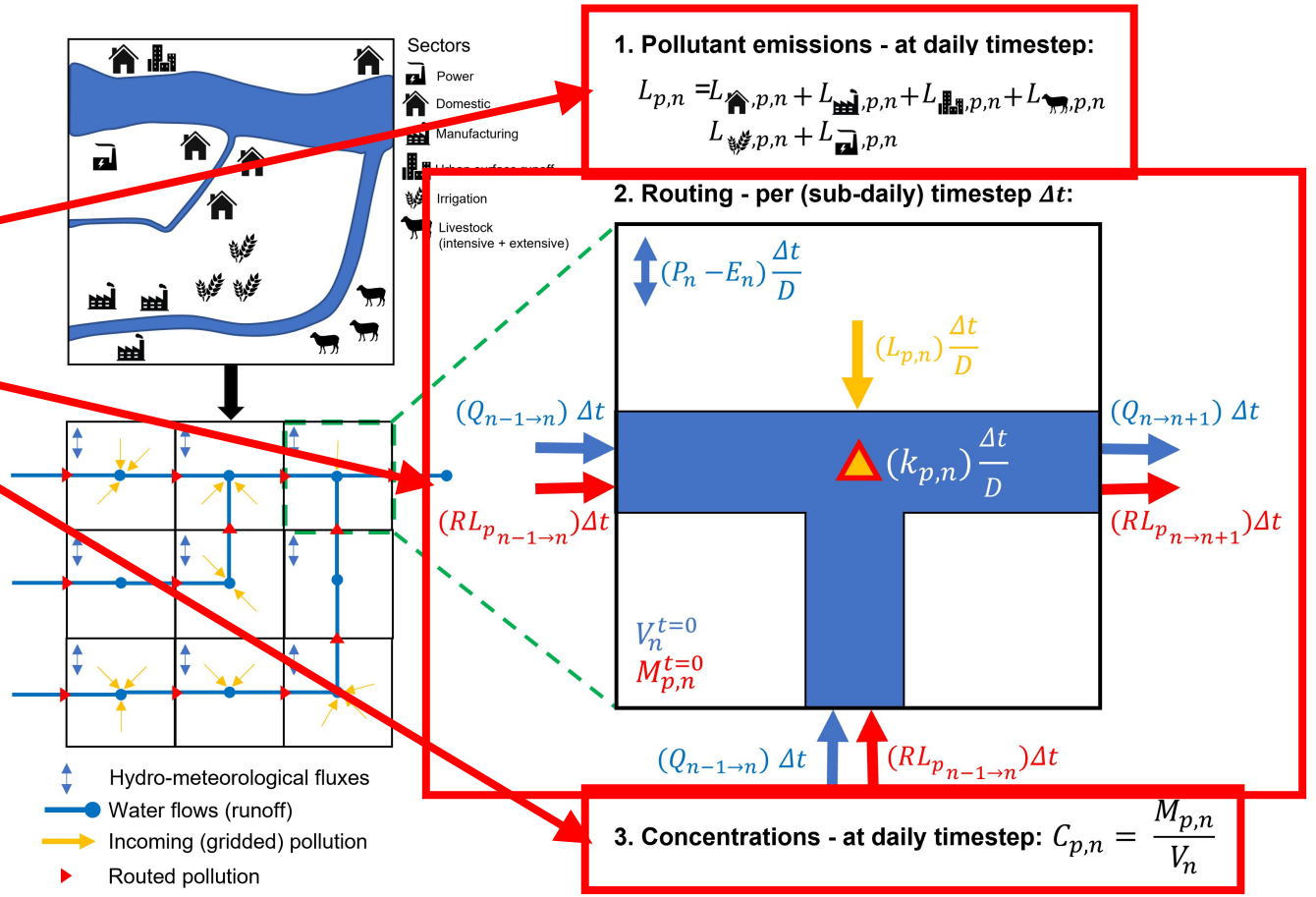


Sutanudjaja et al., (2018), *GMD*

Jones et al. (2022), *GMD*

Dynamical surface water quality model *(DynQual)*

- Global coverage; 5 arc-min (gridded)
- Daily timestep (reporting)
- Coupled to *PCR-GLOBWB2.*
- Approach:
  1. Quantify pollutant loadings
  2. Route loadings through stream network, account for in-stream decay.
  3. Compute in-stream concentrations.

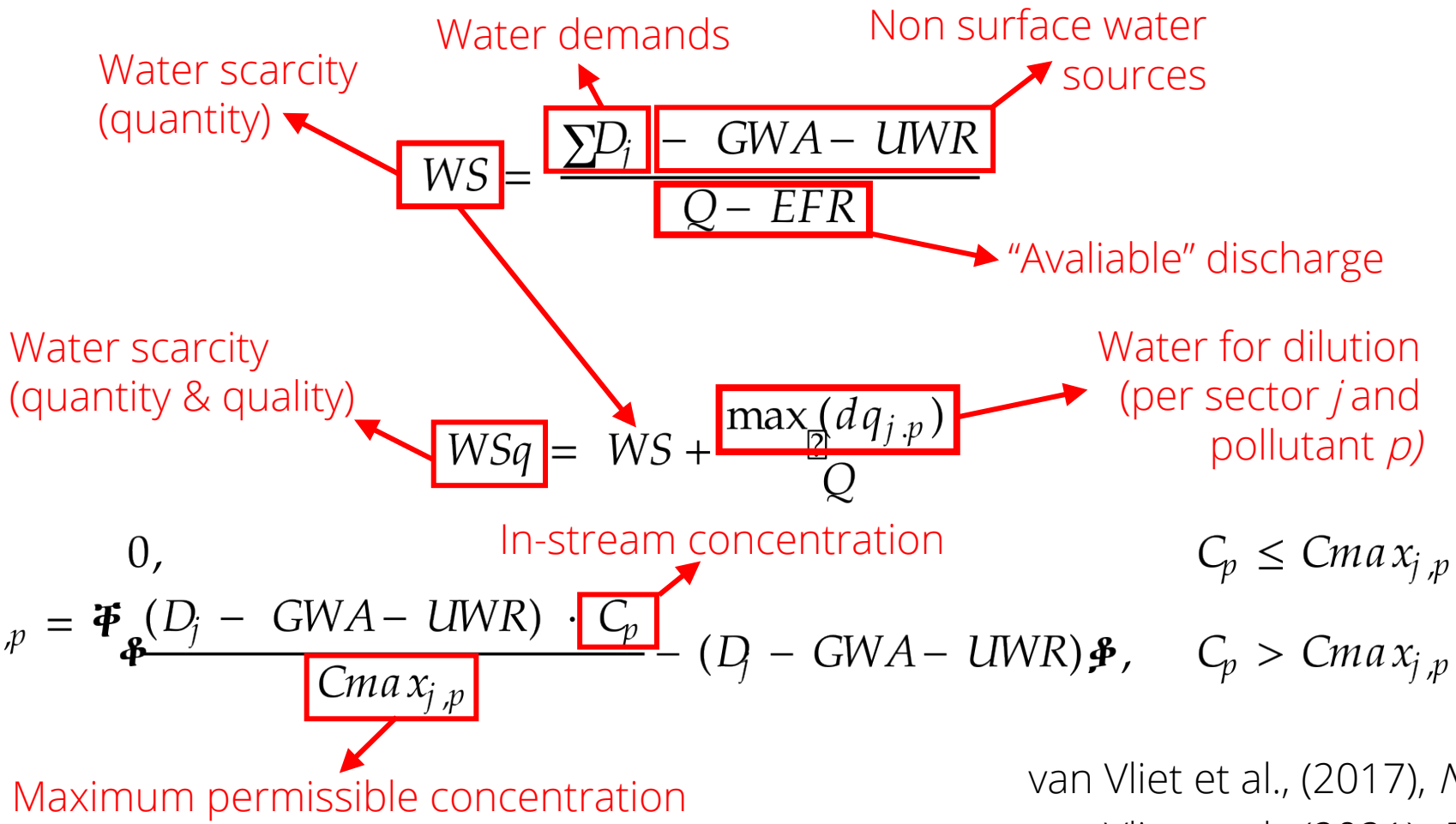


GitHub

UU-Hydro/DYNQUAL

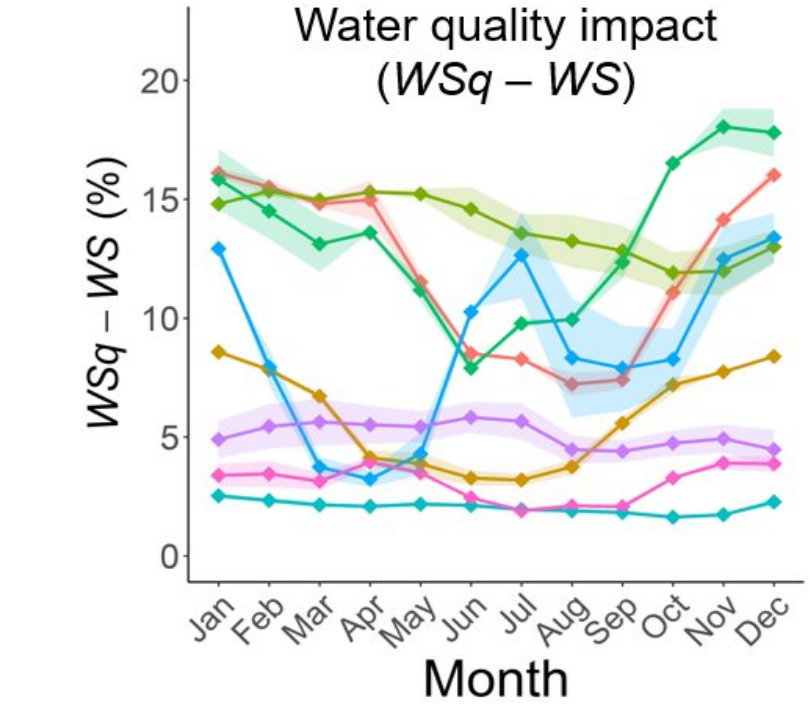
Jones et al. (2022), *GMD*

Estimating (clean) water scarcity



van Vliet et al., (2017), *Nature Geoscience*
van Vliet et al., (2021), *ERL*

Current water scarcity (2005-2020)



- Exposure is highly seasonal and varies strongly across world regions.
- Monthly range in exposure:
  - *WS*: 15% (1 billion) – 30% (2.1 billion)
  - WSq: 24% (1.7 billion)- 37% (2.6 billion)
- 55% (3.8 billion) are exposed to *WSq* at least 1 month per year.

Region
East Asia & Pacific
Eastern Europe & Central Asia
Latin America & Caribbean
Middle East & North Africa
North America
Southern Asia
Sub-Saharan Africa
Western Europe

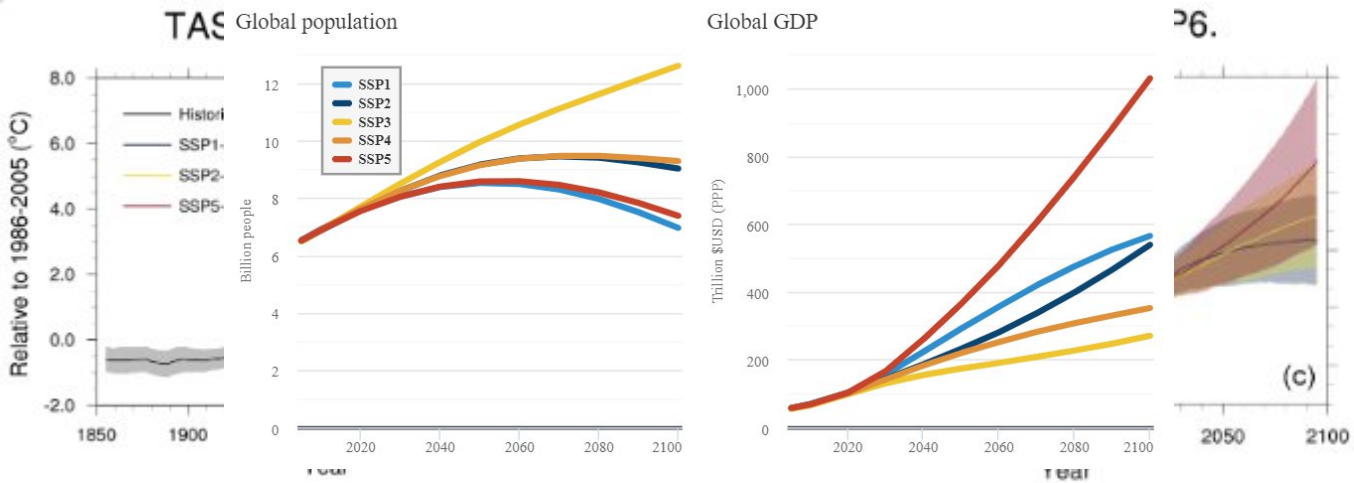
Jones et al. (2024), *Nature Climate Change [In press*

Uncertain futures

- Representative Concentration Pathways (RCPs)
- Shared Socioeconomic Pathways (SSPs)

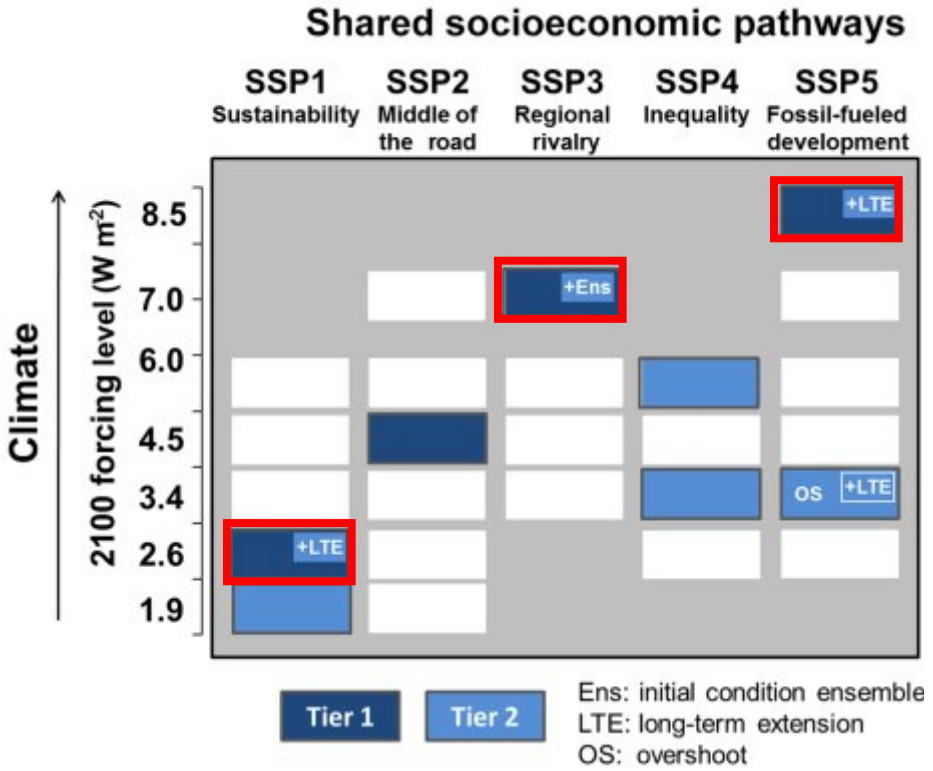
- Multi-faceted impacts on:
  1. Water availability
  2. Water demands
  3. Water quality

} Water scarcity



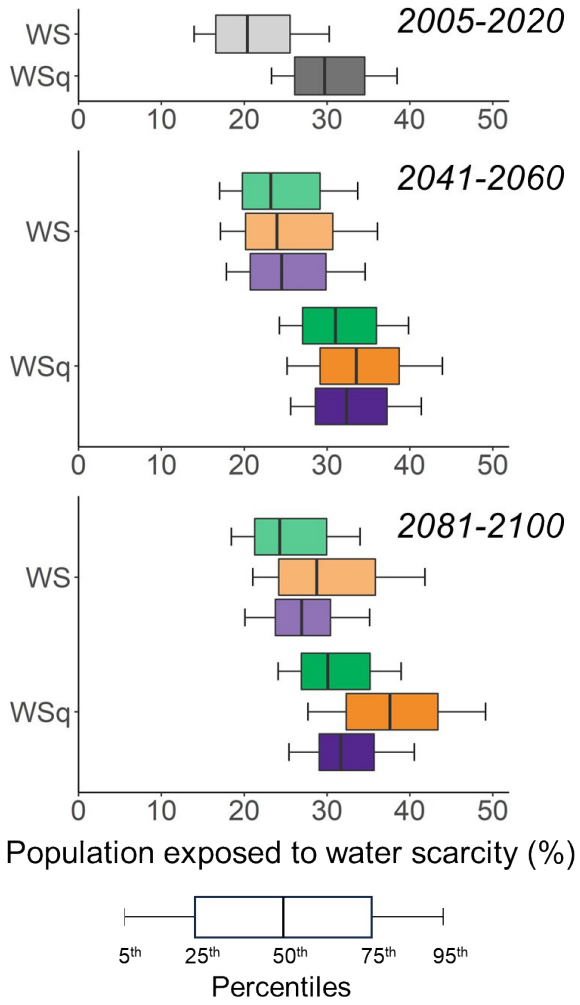
Riahi et al. (2017), *GEC*

Tebaldi et al. (2021), *ESD*



O'Neill et al. (2016), *GMD*

Future water scarcity: global impacts

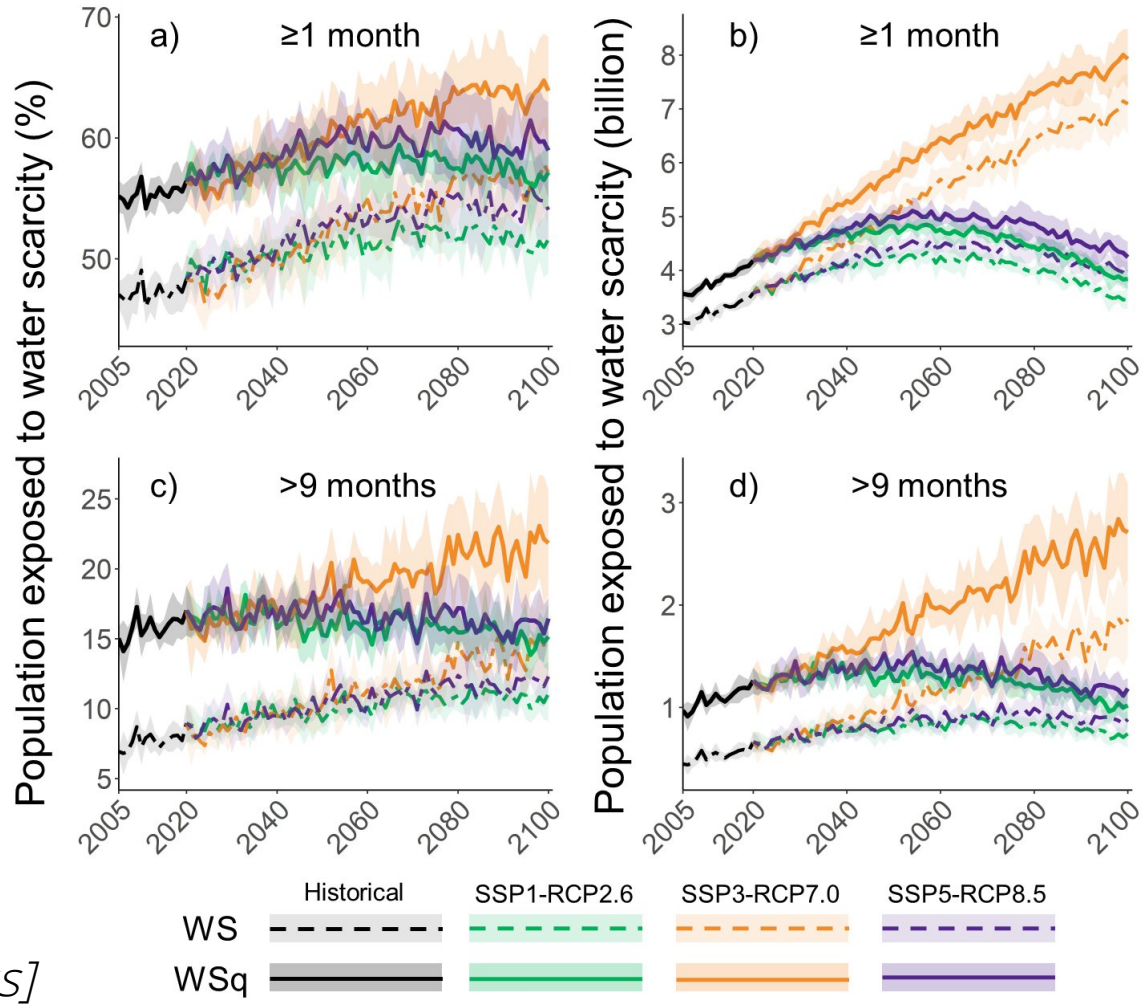


- Under all scenarios, both the proportion and number of people exposed to water scarcity increases.
- Deteriorating water quality under SSP3-RCP7.0 a strong driver.
- Water pollution increases average monthly exposure to WS by 397, 955 and 393 million people by the end-century.

Jones et al. (2024), *Nature Climate Change [In press]*

Future water scarcity: global impacts

- Under all scenarios, both the proportion and number of people exposed to water scarcity at least 1 month per year increases.
- Quantity-driven water scarcity substantially increases under all scenarios.
- Quality-driven water scarcity especially relevant under SSP3-RCP7.0.



Jones et al. (2024), *Nature Climate Change [In press]*

Key messages

- 55% of people currently exposed to WSq >1 month per year.
- Water scarcity drivers and seasonal patterns vary strongly per world region.
- Water scarcity (both excluding and including quality) will get worse in the future.
- Increases in future exposure to water scarcity will disproportionately impact developing countries.
- Reductions in both anthropogenic water use and pollution are necessary to minimise the future clean water scarcity