Perspectives on water quality-induced water scarcity and its drivers

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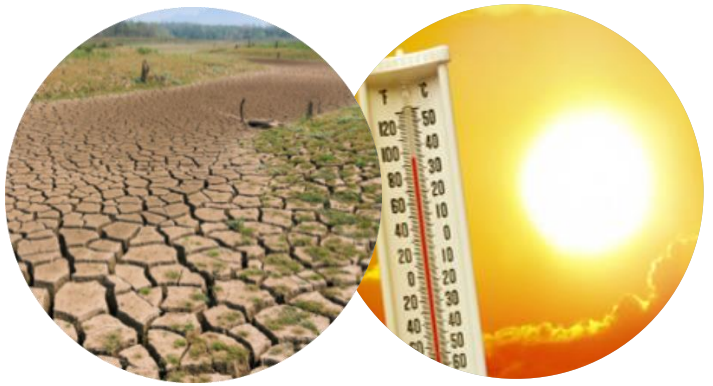
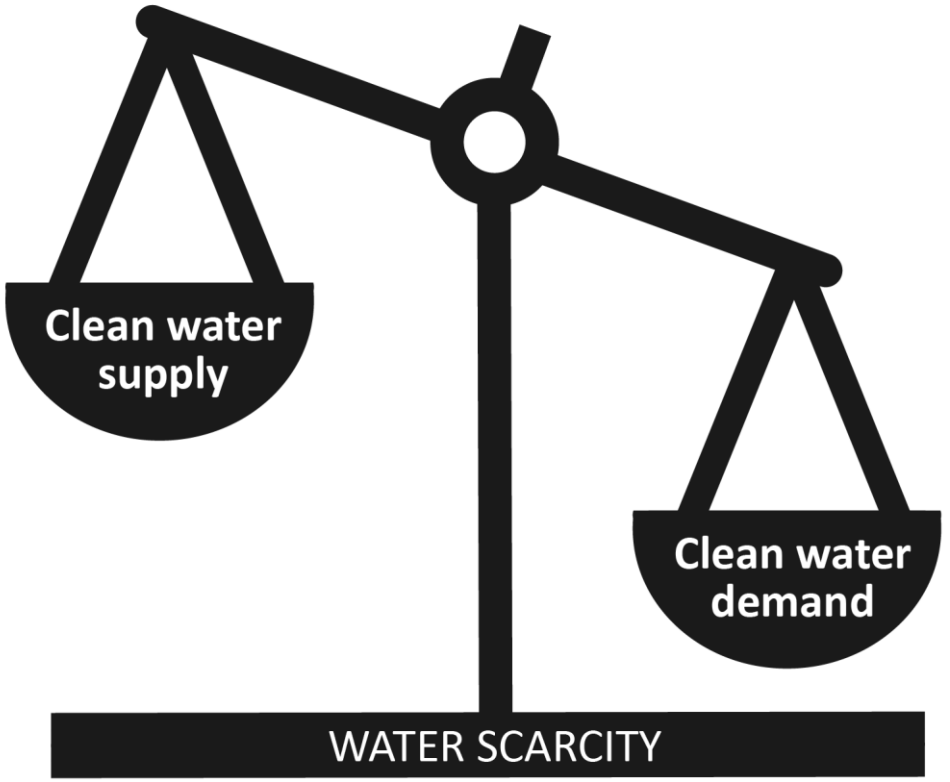
PROCLIAS

What is water scarcity?





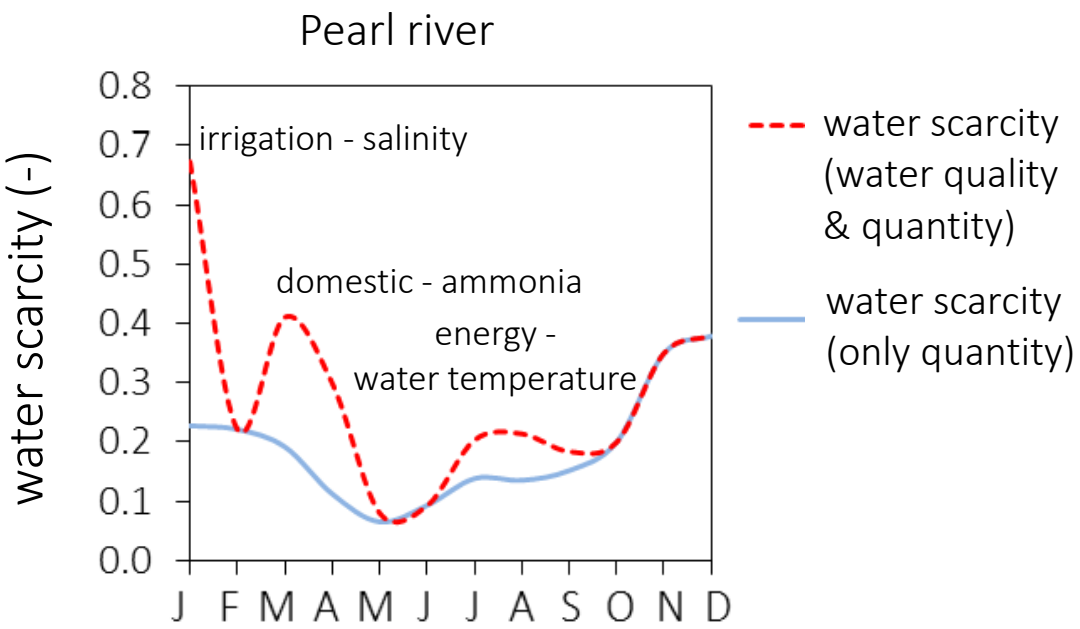
Rethinking water scarcity to include water quality

Quality matters for water scarcity

van Vliet et al. (2017)
Nature Geoscience

Michelle T.H. van Vliet, Martina Flörke and Yoshihide Wada

Quality requirements for water differ by intended use. Sustainable management of wate
different uses will not only need to account for demand in water quantity, but also for w
and salinity, nutrient levels and other pollutants.



ARTICLE

https://doi.org/10.1038/s41467-020-14532-5 OPEN

Ma et al. (2020)
Nature Communications

Pollution exacerbates China's water scarcity and its regional inequality

Ting Ma[1,2,3,8*], Siao Sun[4,8], Guangtao Fu[5], Jim W. Hall[6], Yong Ni[1,2,7*], Lihuan He[7], Jiawei Yi[1,2], Na Zhao[1,2], Yunyan Du[1,2], Tao Pei[1,2,3], Weiming Cheng[1,2], Ci Song[1,2], Chuanglin Fang[2,4] & Chenghu Zhou[1,2*]

ENVIRONMENTAL RESEARCH LETTERS

van Vliet et al. (2021)
Environ. Res. Lett.

LETTER

Global water scarcity including surface water quality and expansions of clean water technologies

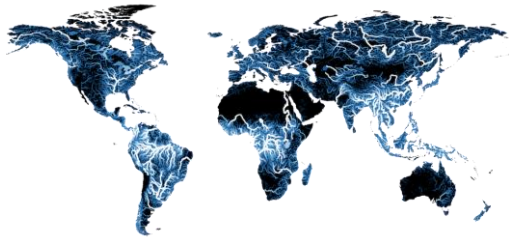
Michelle T H van Vliet[1,2], Edward R Jones[1], Martina Flörke[3], Wietse H P Franssen[2], Naota Hanasaki[4], Yoshihide Wada[5,1] and John R Yearsley[6]

Water scarcity model framework

water quantity

water quality

water supply



water availability

water quality

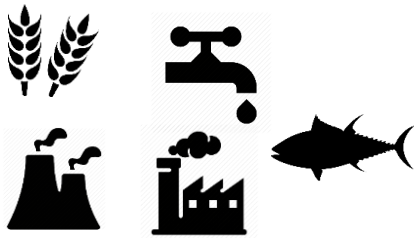
- water temperature
- salinity (TDS)
- organic pollution (BOD)
- nutrients (TN, TP)

desalination

water scarcity

treated wastewater reuse

water demand



sector water use

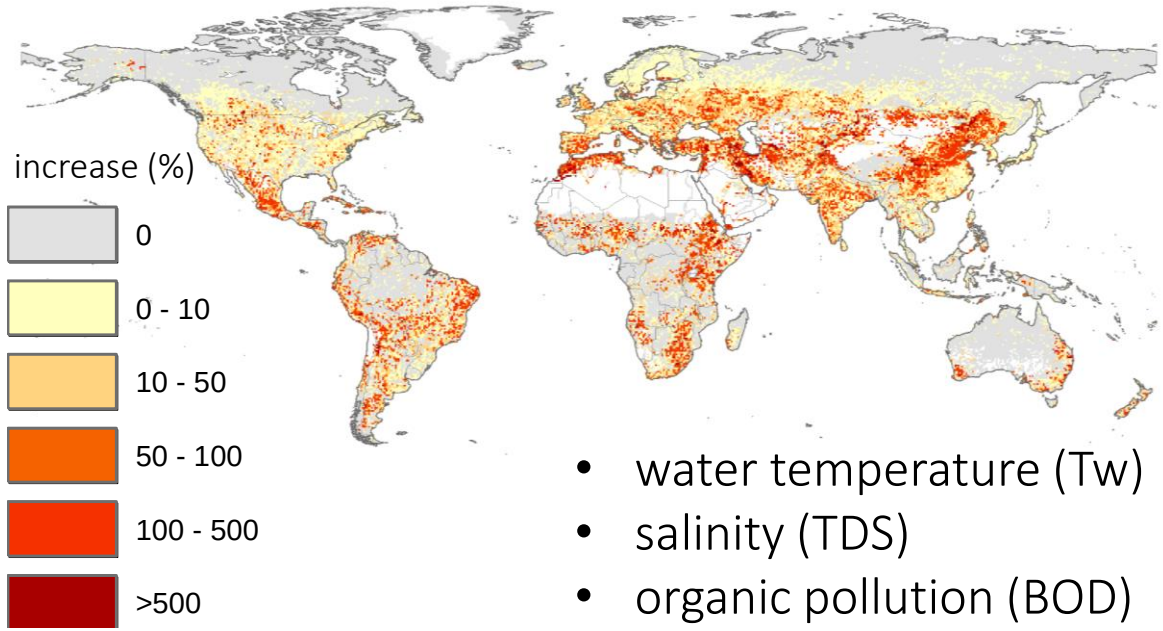
sector water quality requirements

0.5 degree, monthly timestep

van Vliet et al. (2021) Environ. Res. Lett.

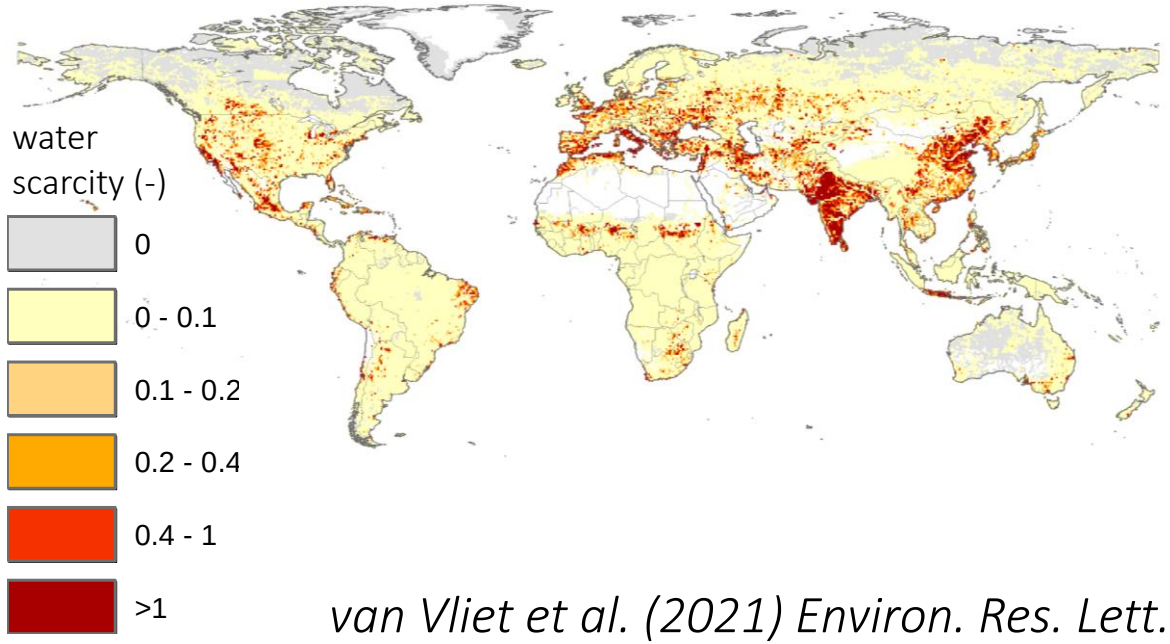
Water quality impacts on global water scarcity

Change in average water scarcity by including water quality
2000-2010



- water temperature (Tw)
- salinity (TDS)
- organic pollution (BOD)
- nutrients (TN, TP)

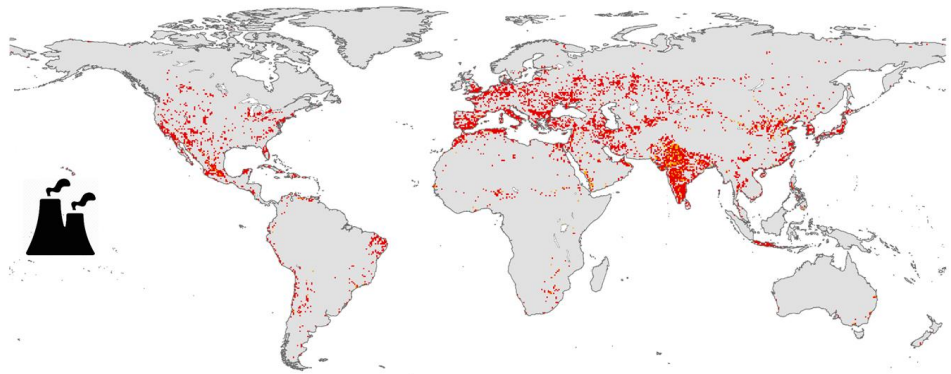
Average water scarcity including water quality
2000-2010

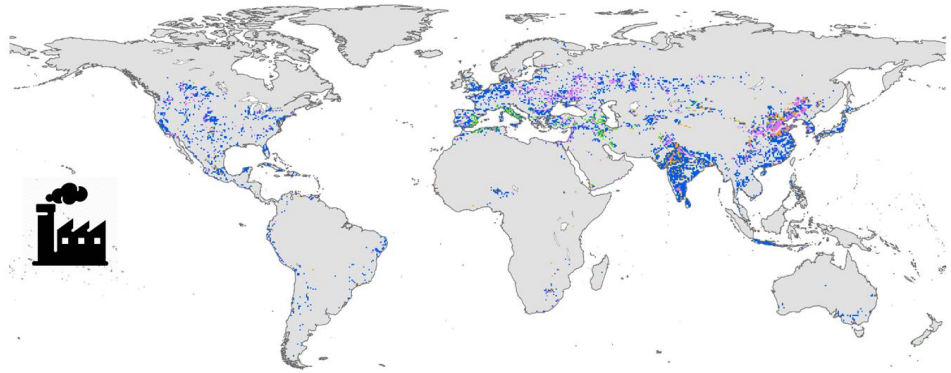


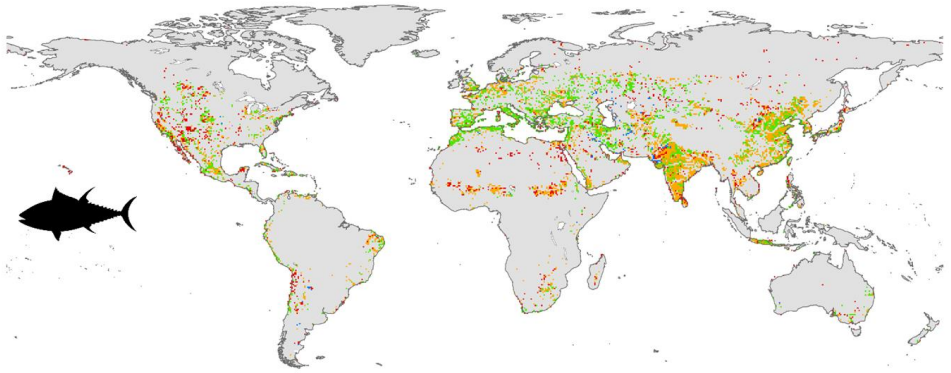
van Vliet et al. (2021) Environ. Res. Lett.

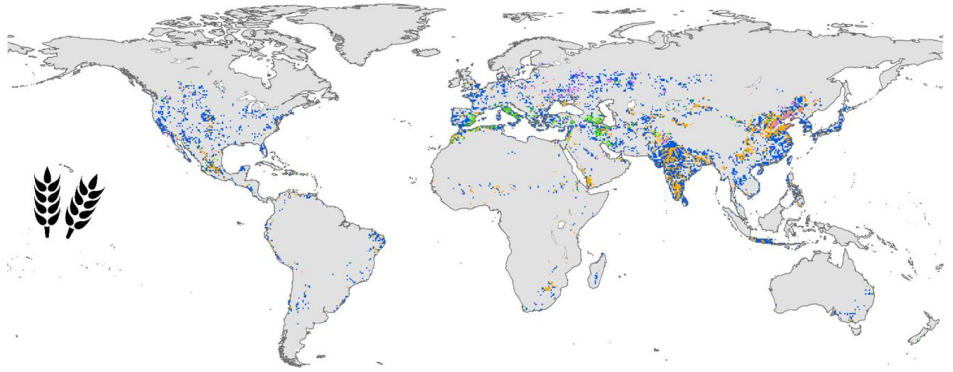
- Increases in **world's population under severe water scarcity** from **30%** (only water quantity) to **40%** (both water quantity and quality)
- **Water scarcity** driven by both **water quantity** and **quality** issues in **hotspots** regions

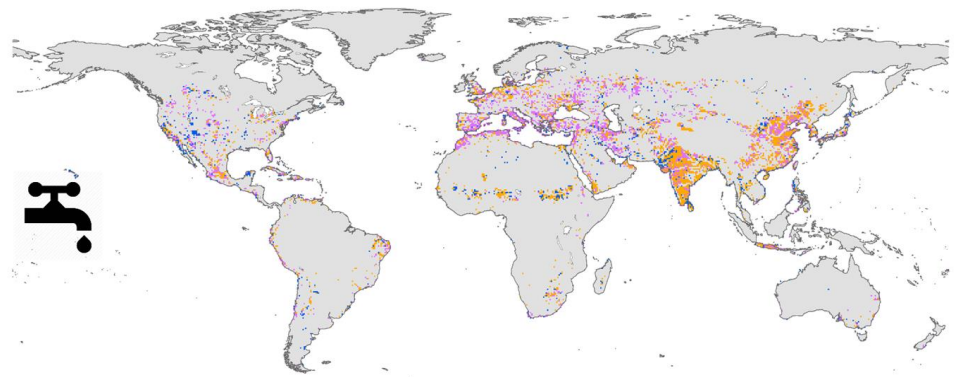
Critical water quality constituent for sectoral water use











water temperature (Tw)

salinity (TDS)

organic pollution (BOD)

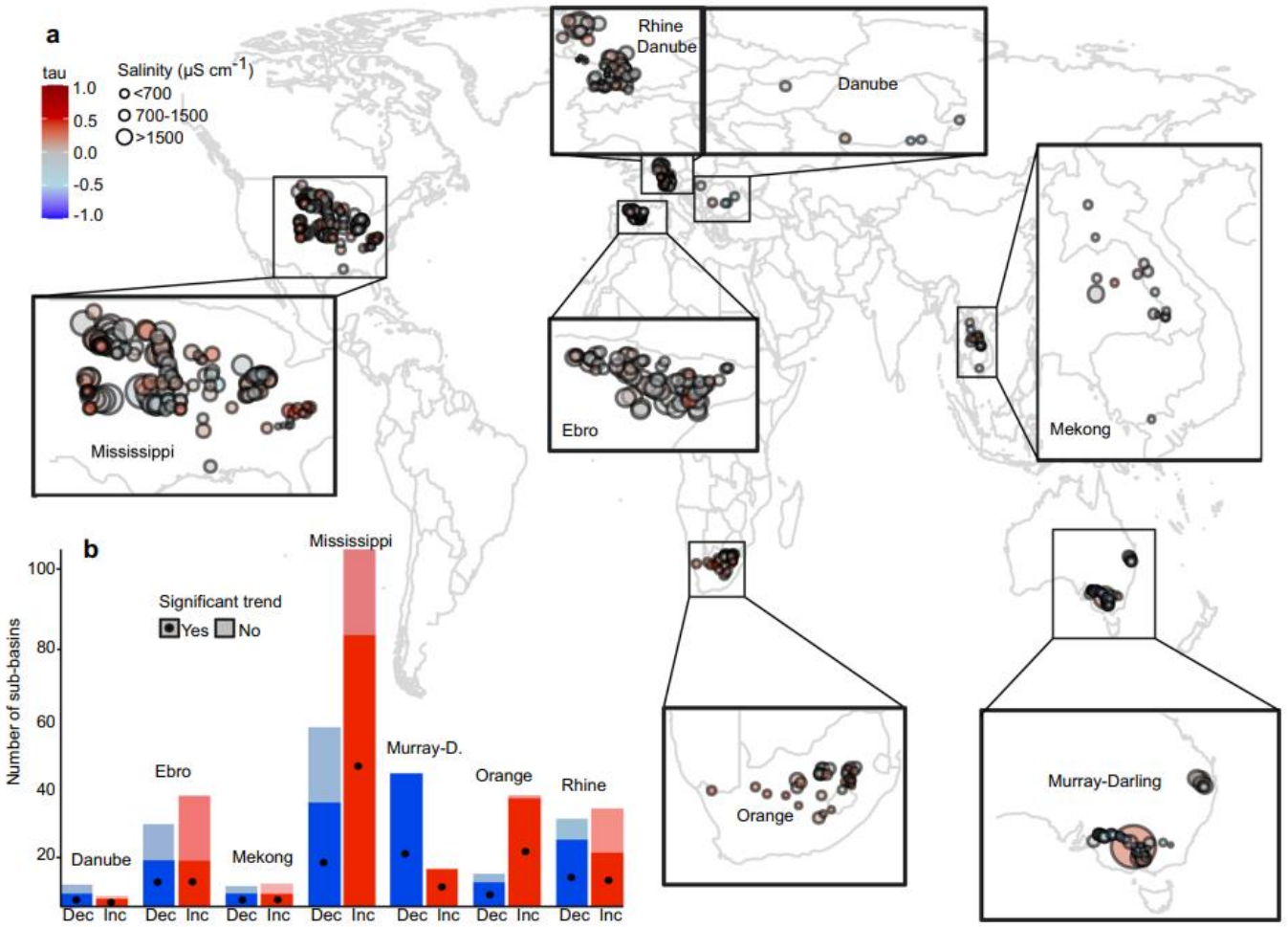
total nitrogen (TN)

total phosphorous (TP)

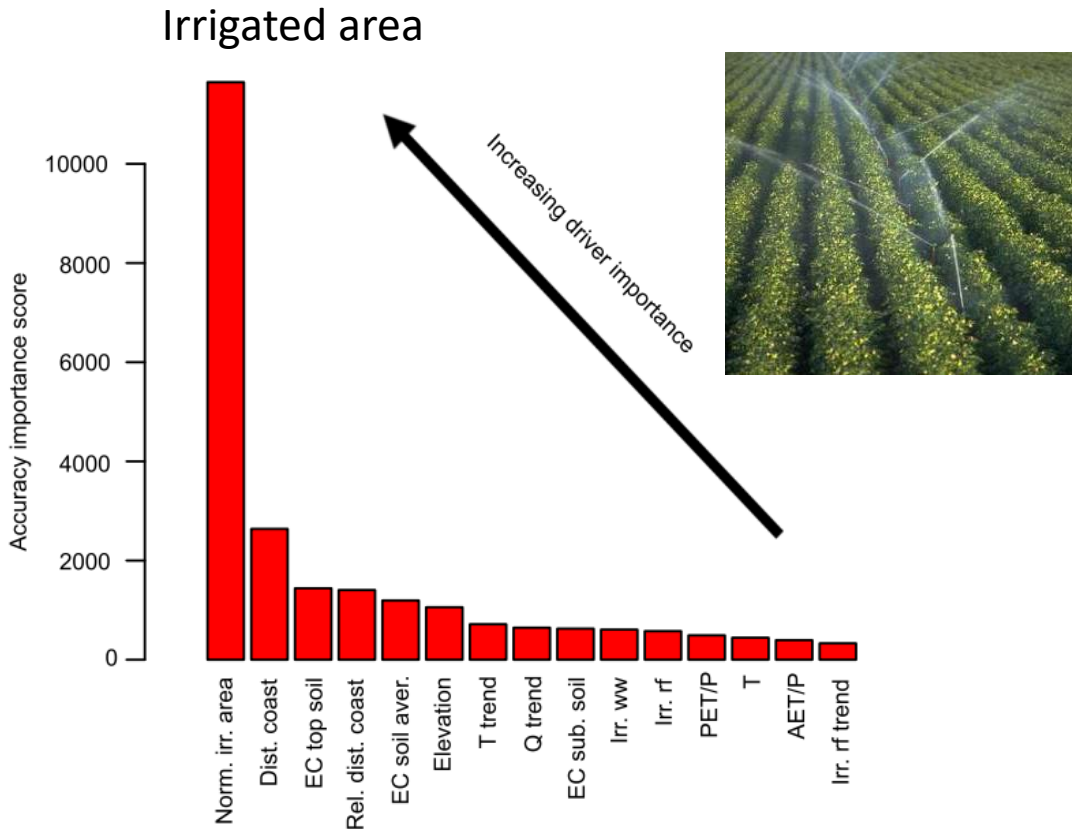
van Vliet et al. (2021) Environ. Res. Lett.

Irrigation ⟷ freshwater salinization

Trends in surface water salinity 1980–2010

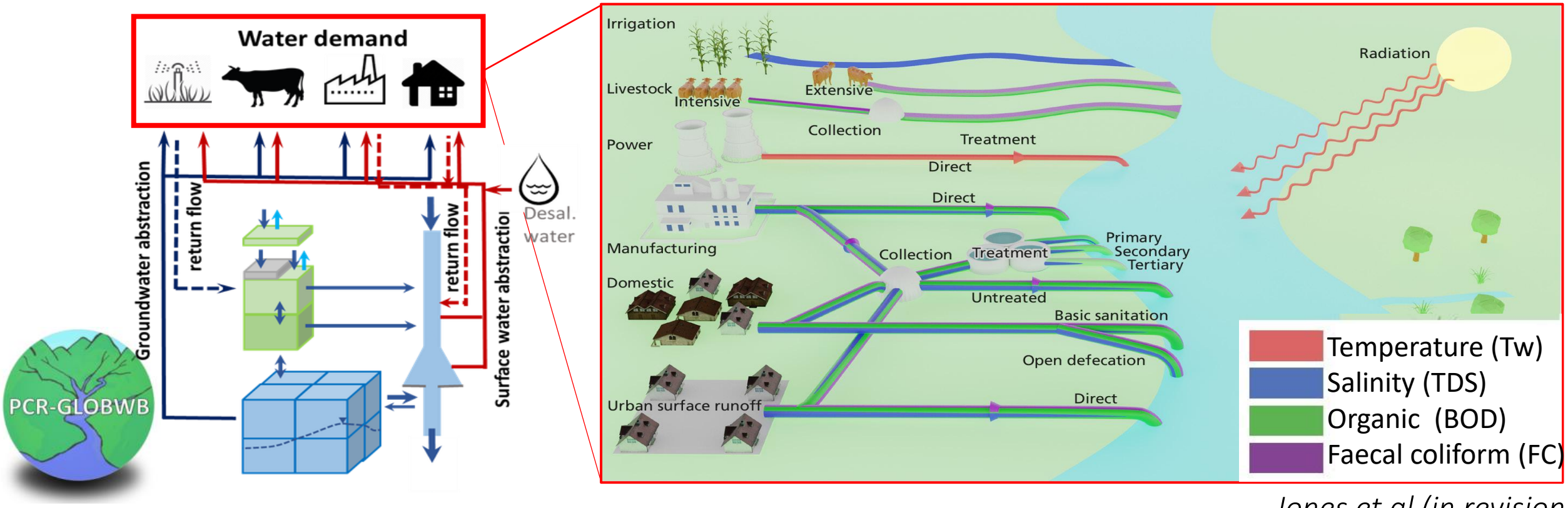


Thorslund et al. (2021), Nature Communications



Irrigation is important driver of freshwater salinization

DynQual: high-resolution surface water quality model



Jones et al (in revision)

Approach:

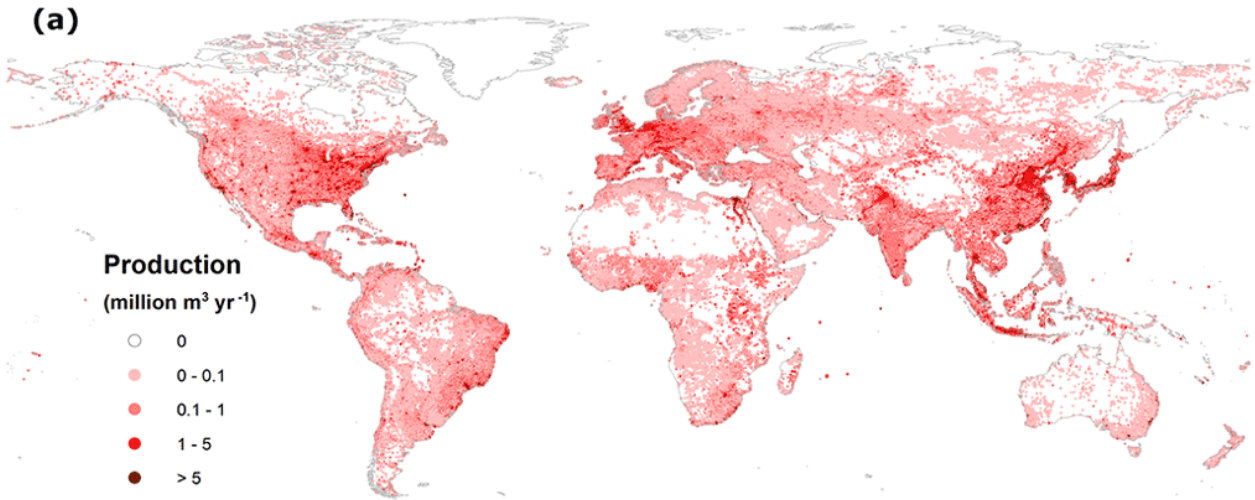
1) Quantify **pollutant loadings**;

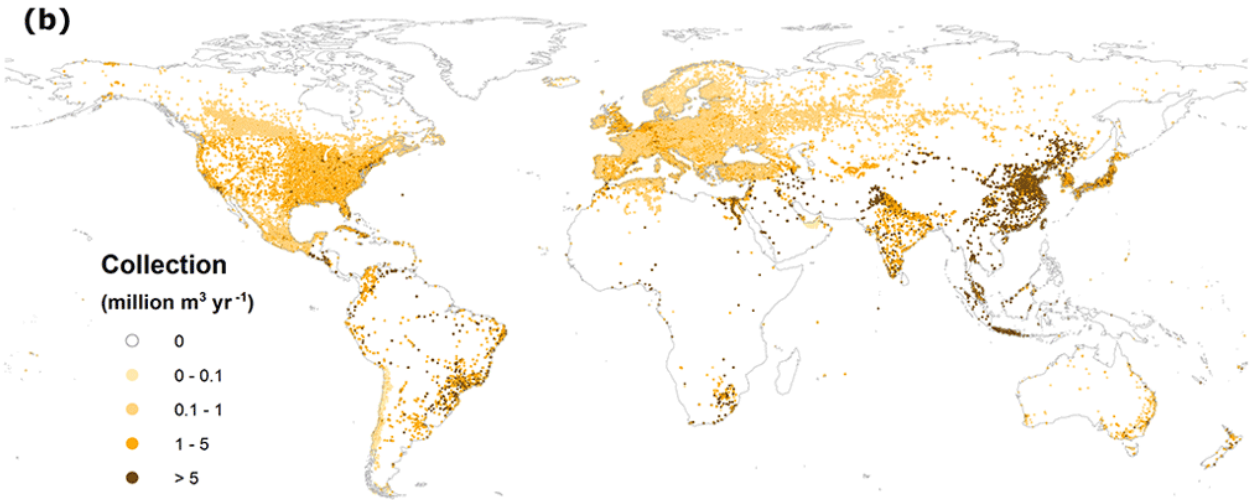
2) **Route loadings** through the stream network, accounting for **decay** processes;

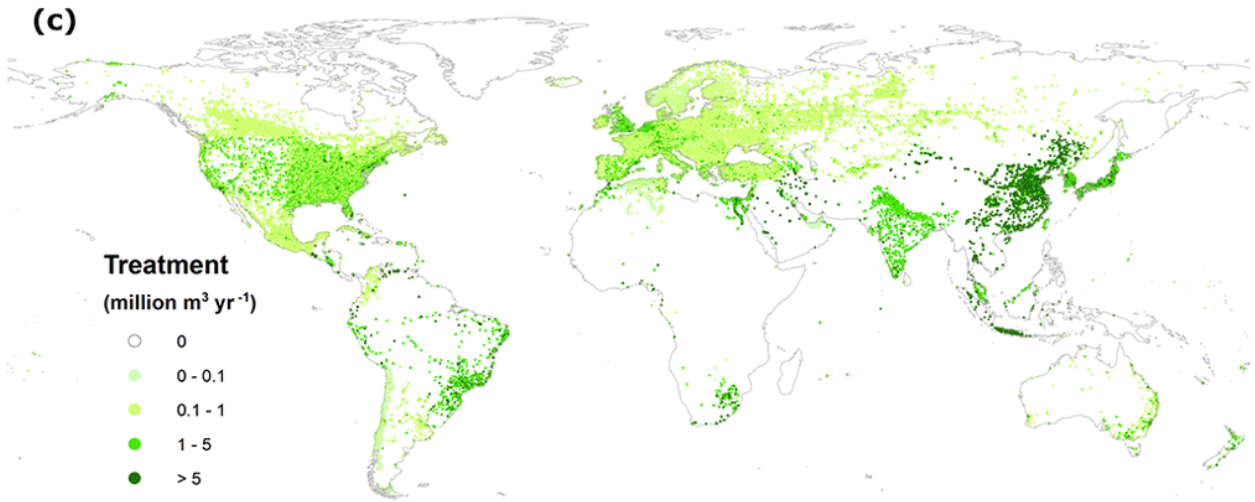
3) Compute in-stream **concentrations**.

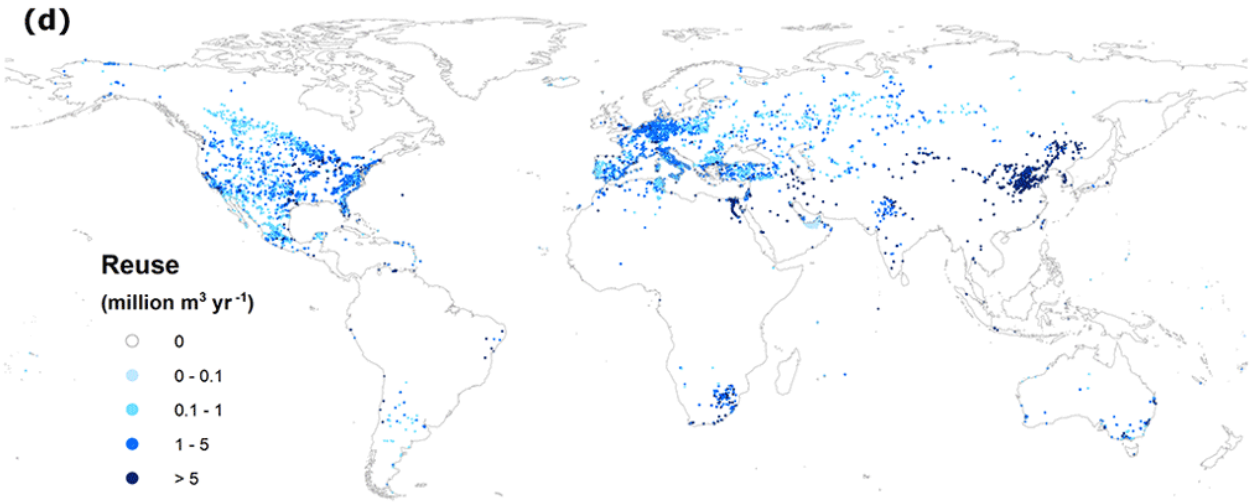
- 5 arcmin (10km) globally
- daily timestep → climate extremes (droughts, heatwaves)

Wastewater production, collection, treatment and reuse









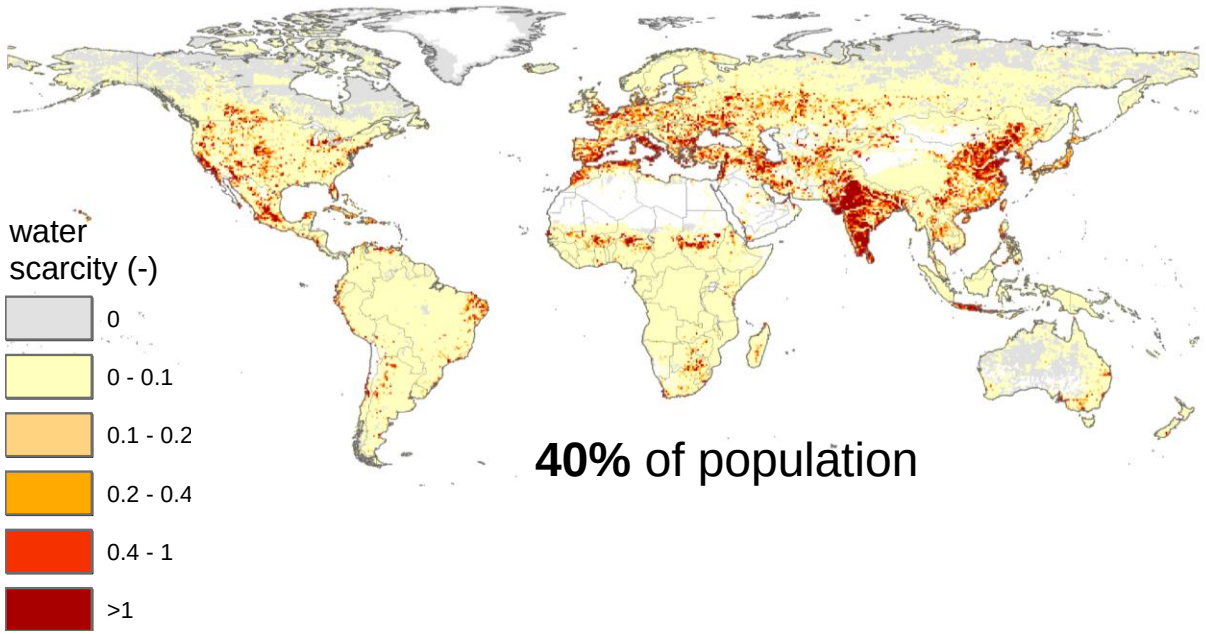
Jones et al (2021), Earth System Science Data

Expansion in desalination and treated wastewater reuse

SDG 6.4: reducing the number of people suffering from severe water scarcity

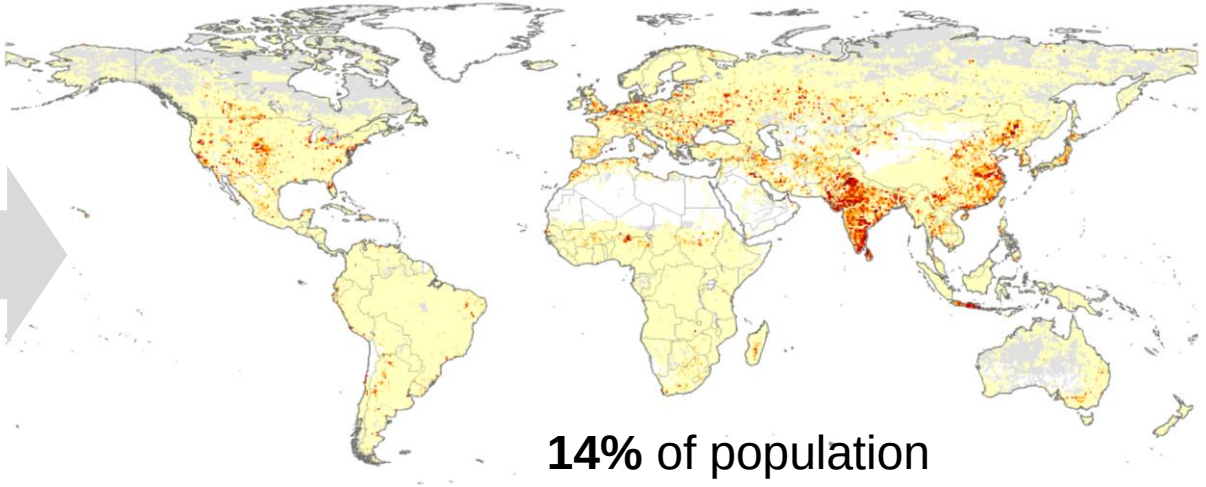
- Expansion in treated wastewater reuse for irrigation
- Expansion in desalination (inland/sea water) for domestic and industrial uses

Water scarcity - present



40% of population

Water scarcity - incl. expansion in desalination & treated waste water reuse



14% of population

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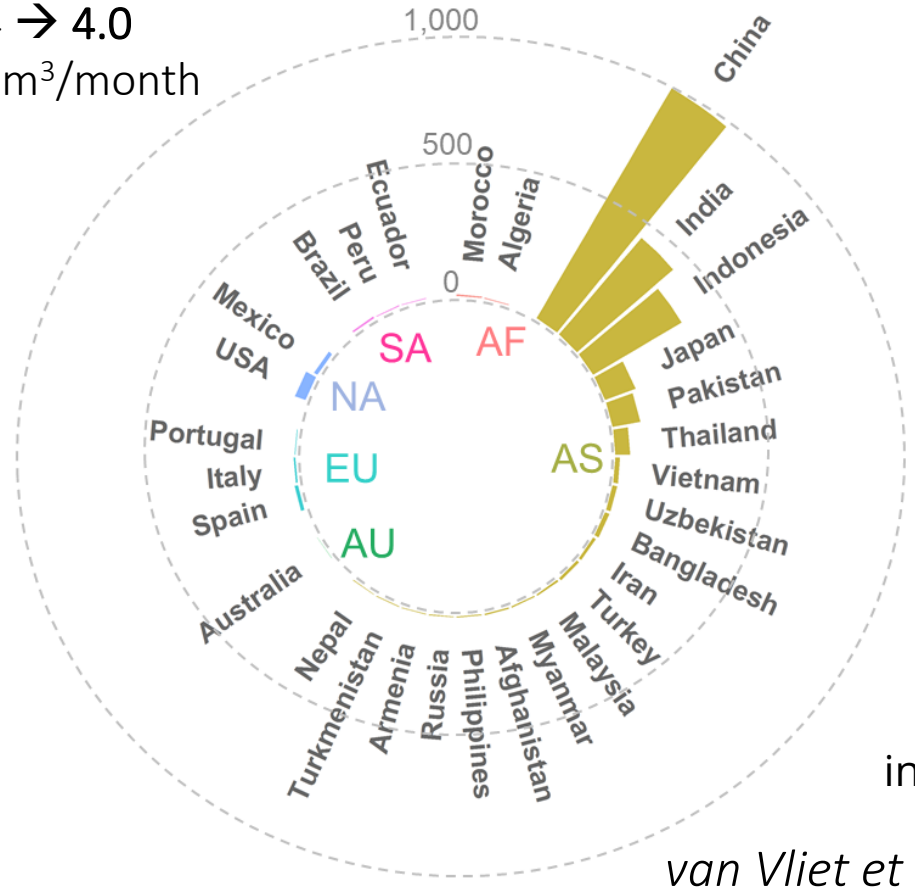
Expansion in desalination and treated wastewater reuse

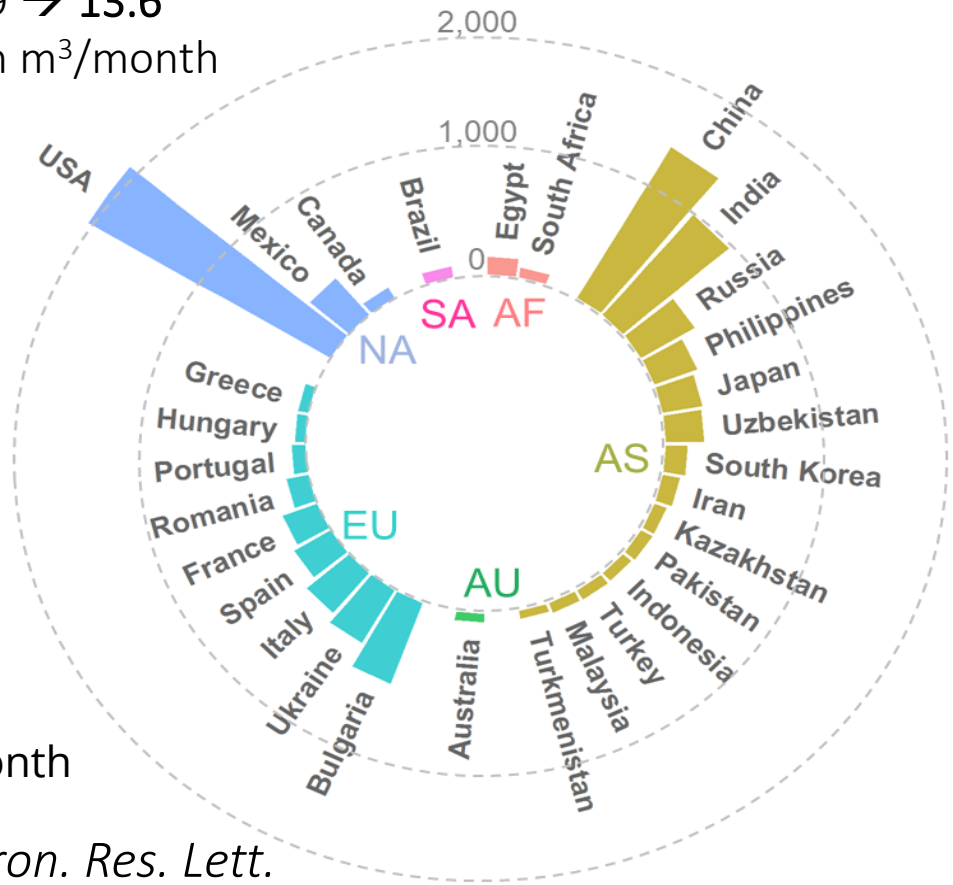
Treated waste water reuse expansion

1.4 → **4.0**
billion m^3/month



Desalination expansion

2.9 → **13.6**
billion m^3/month



in millions m^3/month

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- From resource perspective only
- Technical, socio-economic and environmental constraints and side-effects (energy demands, brine, costs) of technologies must be considered

Quality matters for water scarcity and its drivers

- **New water scarcity indicators** and **modelling framework** including impacts of **water quality** and **water technologies**
  - **Regional hotspots** of **water scarcity**, both in terms of **water quantity** and **quality**
  - Historical and future **trends in water quality** and **water scarcity** and their drivers

- **Expansions in water technologies to improve water quality** (SDG6.3)and **alleviate water scarcity** (SDG6.4)
  - Expanding **desalination** and **treated wastewater reuse** can strongly **reduce water scarcity**, especially in **hotspot regions** (e.g. eastern China and India).
  - The **side effects of these technologies** (e.g. brine, energy demand, cost) should be considered

Literature

Jones. E.R., M.T.H van Vliet, M. Qadir, M.F.P Bierkens (2021) Country-level and gridded estimates of wastewater production, collection, treatment and reuse, *Earth System Science Data*, 13, 237–254

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Thank you!

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