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WATER QUALITY IMPACTS – PERSPECTIVES ON FOOD

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Water quality

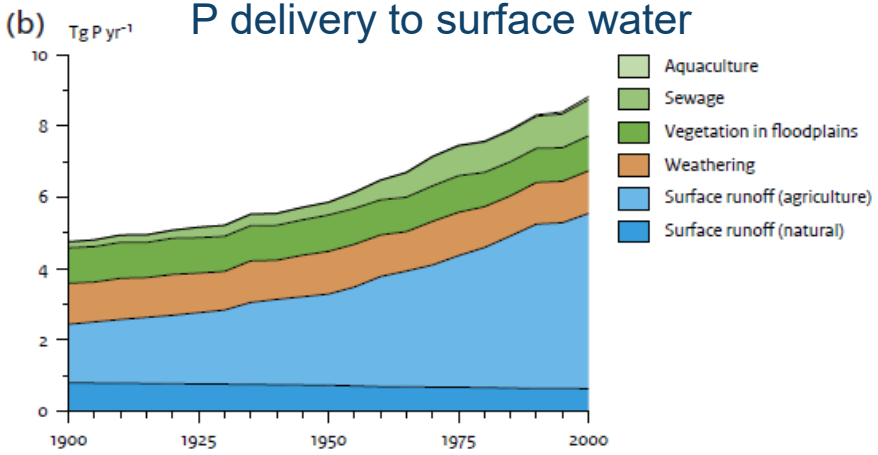
- **More than 80% of the wastewater worldwide is disposed untreated into the environment**
- **Nutrient pollution remains one of the most common forms of water pollution. Most of it comes from agriculture**

Agriculture as a source of water pollution

- **Agriculture has expanded and intensified over decades to meet growing demand**
- **Higher yields and production are often linked to excessive use (or misuse) of fertilizers, pesticides or other chemicals**
- **Excess nutrients and chemicals can leach into surface water and groundwater**

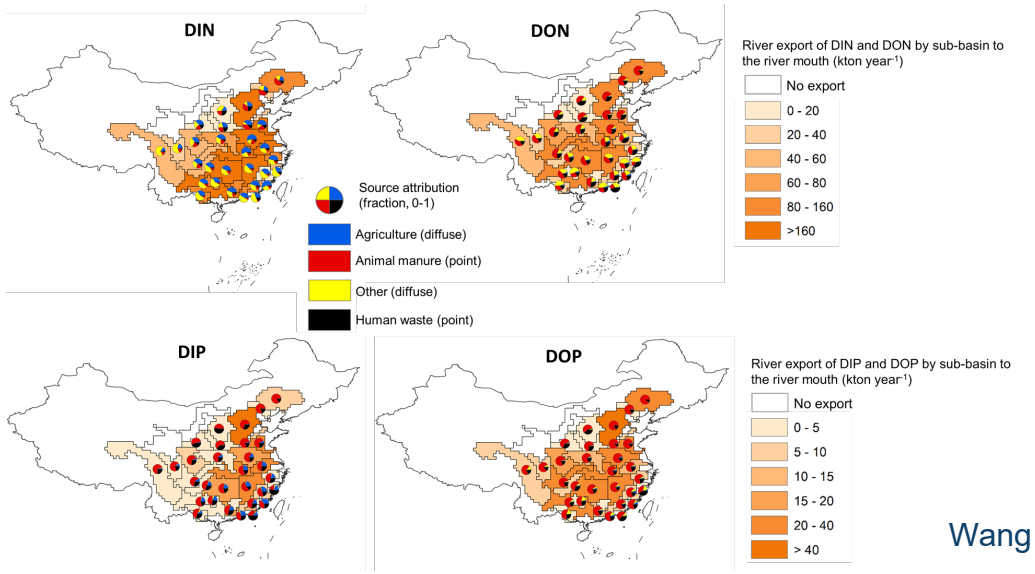
WWAP (2017)

Agriculture as a source of water pollution

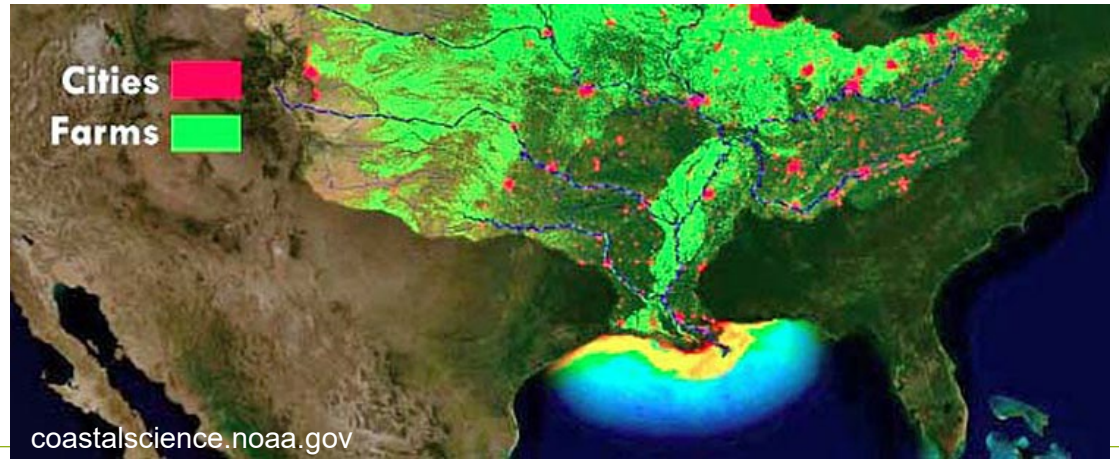


P delivery to surface water

Beusen et al. (2016)



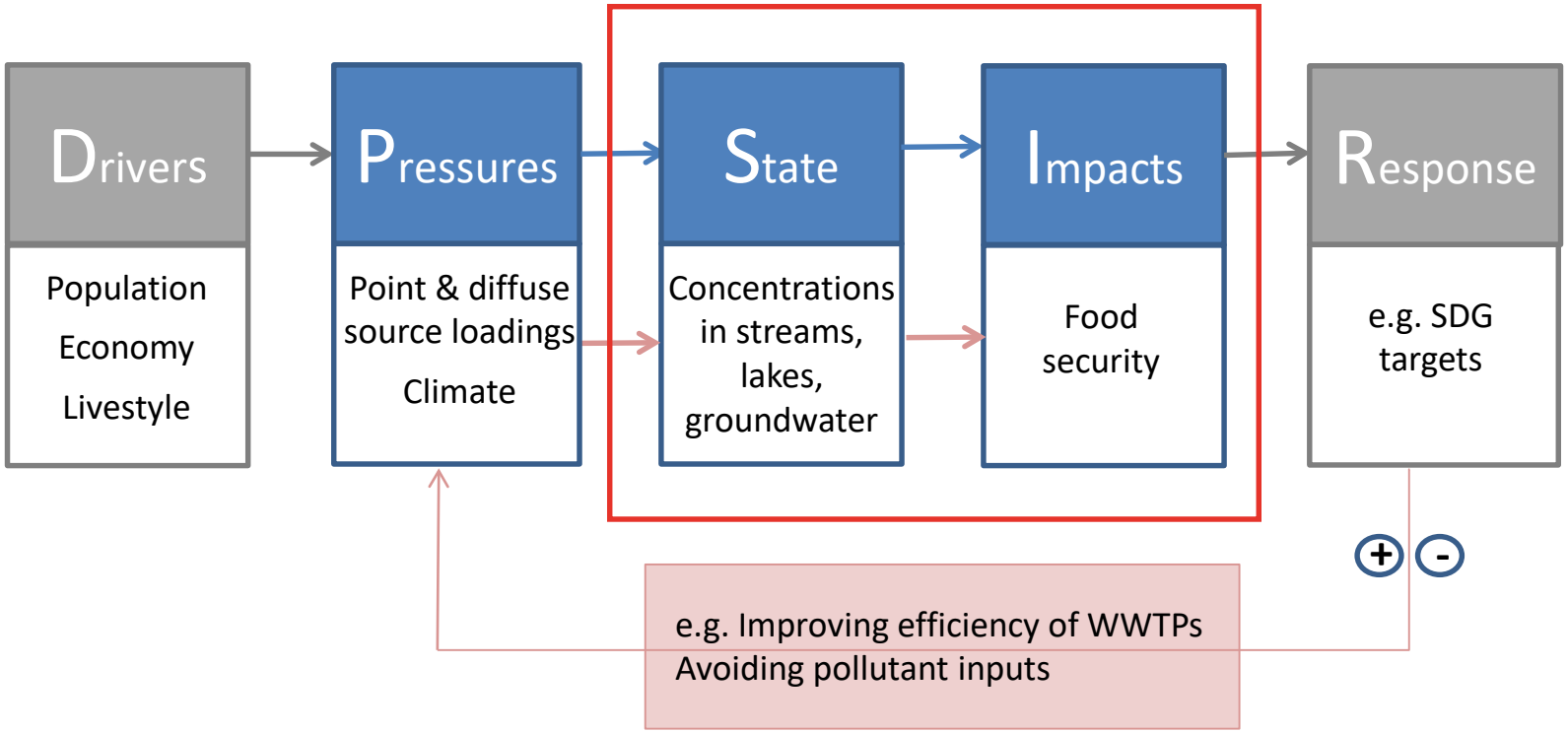
Wang et al. (2020)



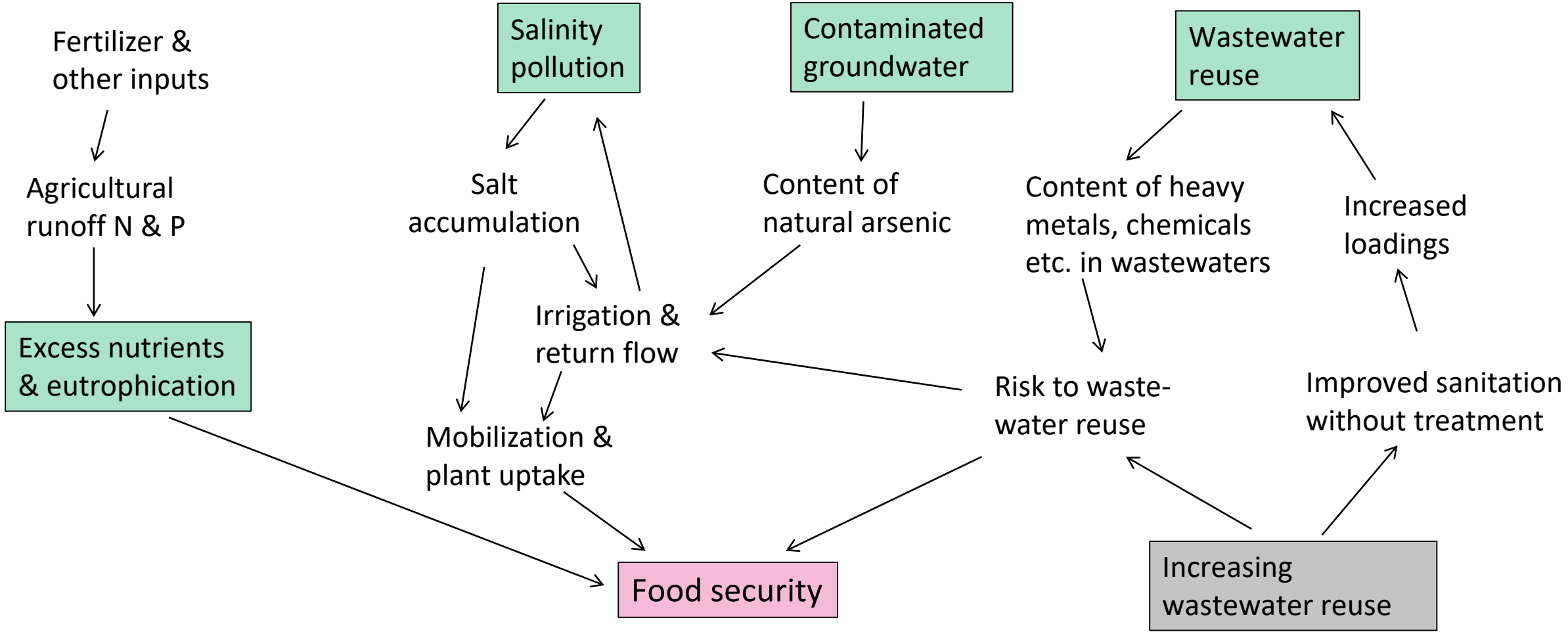
Gulf of Mexico Hypoxic Zone, or Dead Zone (23,000 km²)

- area of no/low oxygen that can kill fish and marine life near the bottom of the sea

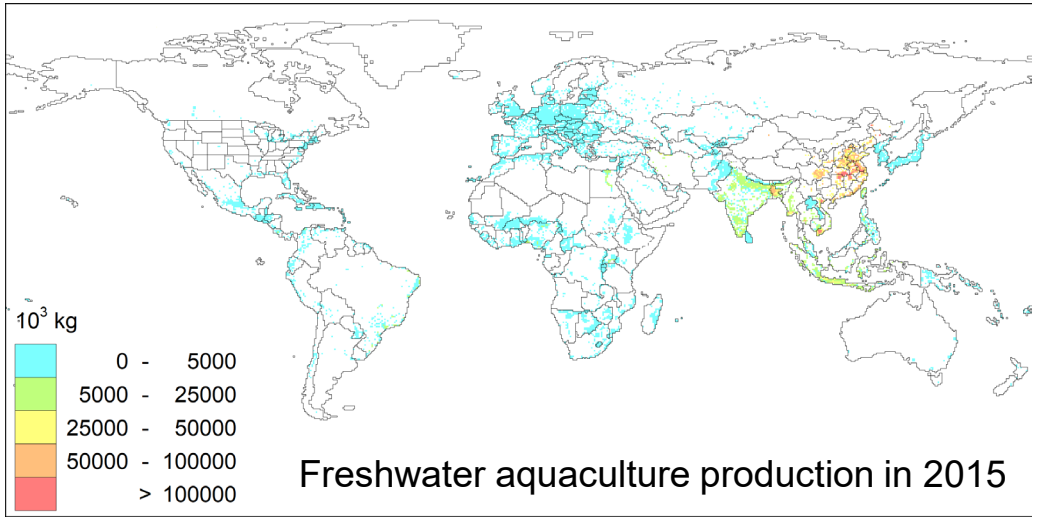
Freshwater degradation affects food security



Water quality affecting food security



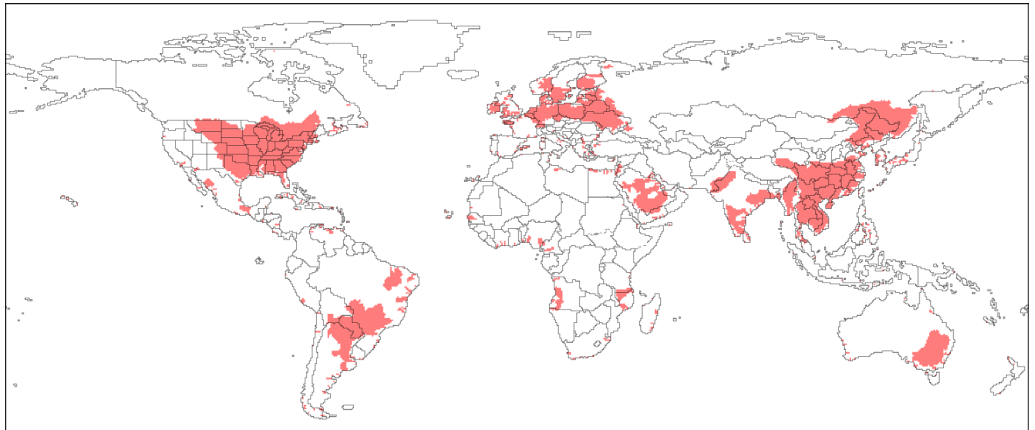
Example 1: Excess nutrients & eutrophication



Freshwater aquaculture production in 2015

Threats to inland fishery

- Aquaculture systems in cages, as well as shellfish production are sensitive to water pollution and algal blooms
- Freshwater aquaculture production may be at risk in southern and eastern Asia
- When N:P exceeds 25:1, the frequency and areas of HABs may increase rapidly



Rivers with anthropogenic-dominated sources and high molar N:P ratio in the discharge to coastal waters

Beusen et al. (2015, 2016)

Example 2: Soil salinity

The great salty mess: pollution threatens US fresh water resources

Wastewater from cities and agricultural runoff are contributing to an expensive salinity problem, and companies – especially when faced with new water purification bills – are taking notice

www.theguardian.com

- **831 million ha** of land area affected by soil salinity
- **34 million ha** salinized by irrigation (11% of irrigated area)
- In 2009, about **1.1 billion people** lived in regions that had saline groundwater at shallow depth.
- Cost of salt-induced land degradation in irrigated areas estimated to be **US$ 27.3 billion**

Sources: IGRAC (2009), Mateo-Sagasta & Burke (2010), Quadir et al. (2014), Butcher et al. (2016), FAO (2017)

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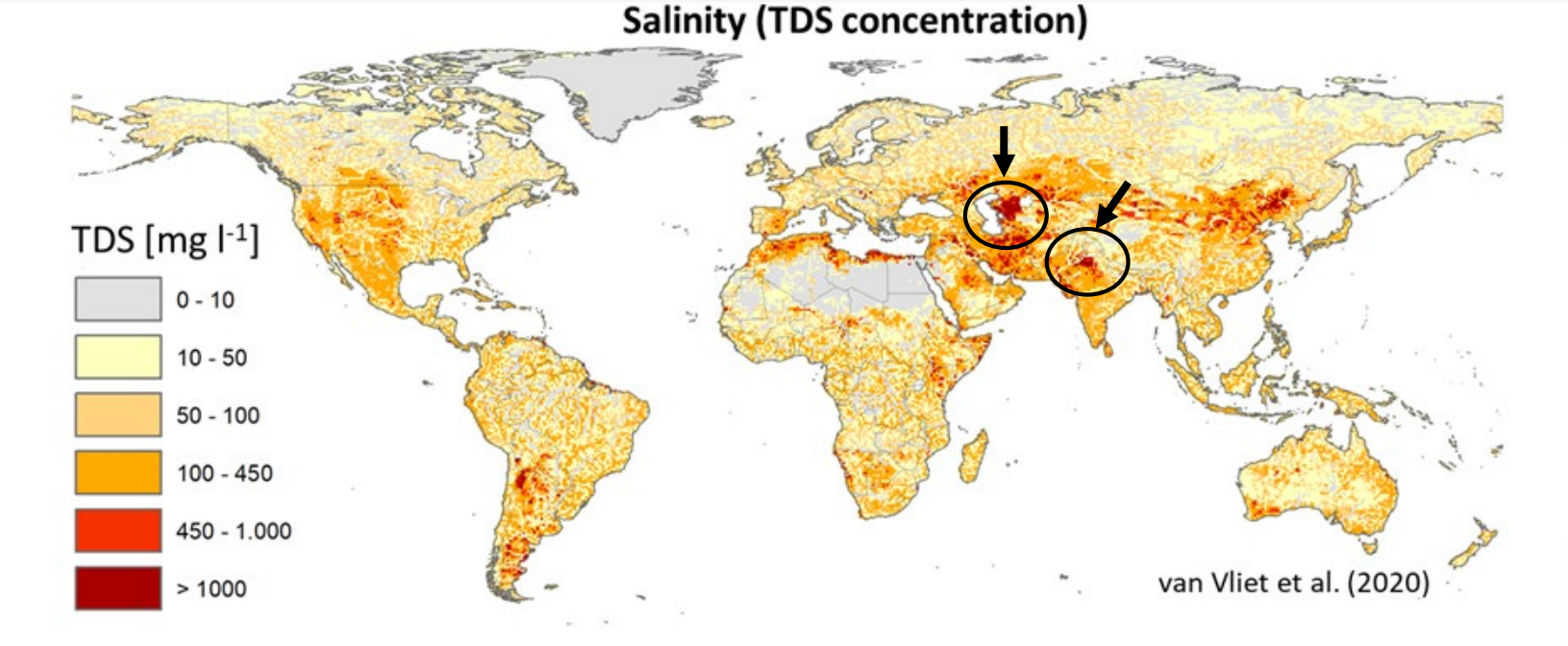
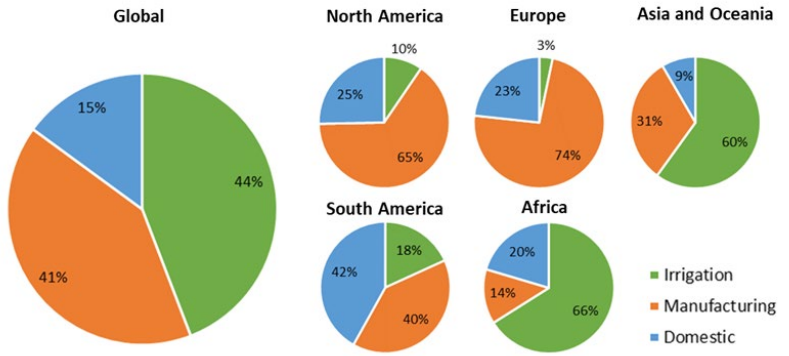
What is the level of salinity pollution?



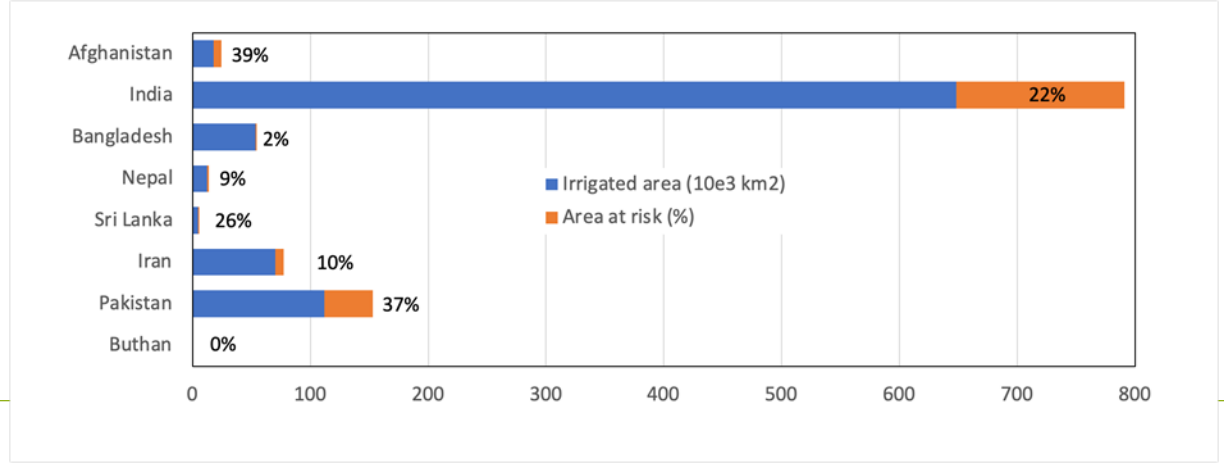
Anthropogenic loads

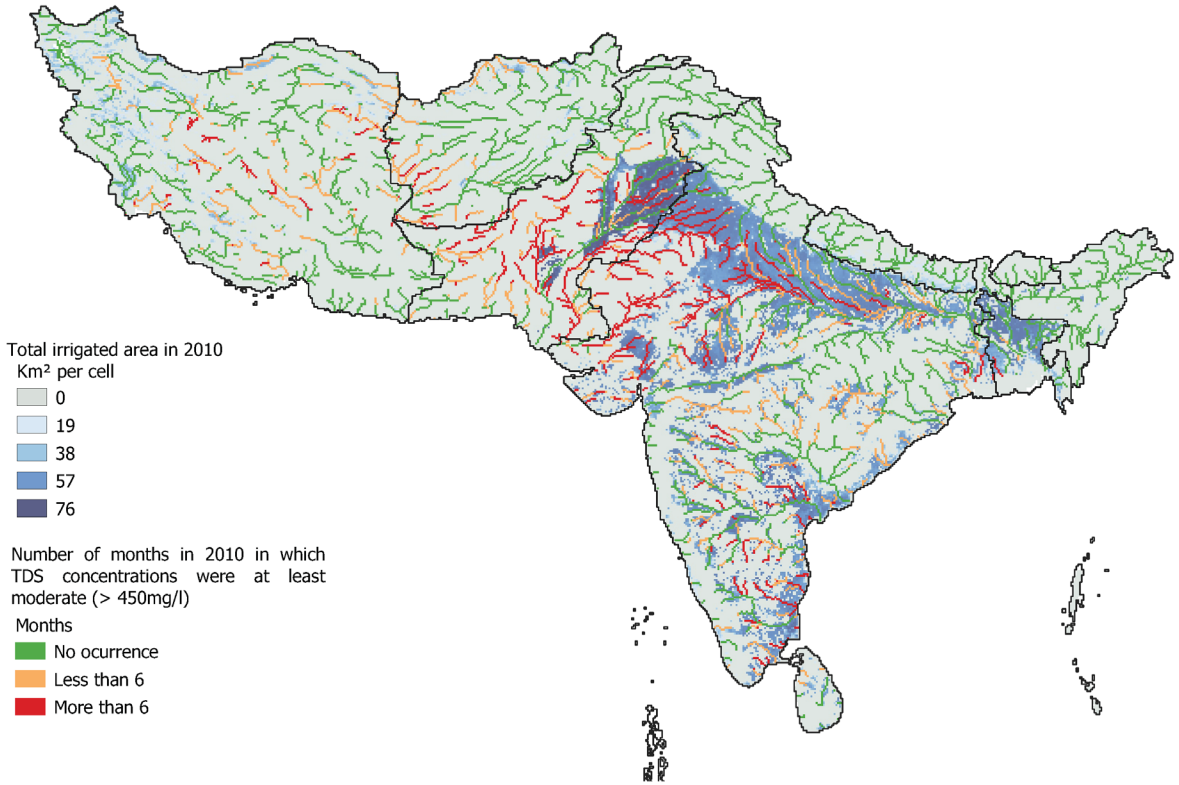


- TDS as a metric for salinity pollution
- Hotspots of high TDS in-stream concentrations in north-eastern China, India, the middle East, Africa, parts of South America, Mexico, USA, Mediterranean region
- Hotspots relate to irrigated land in arid regions

Threat of salinity pollution

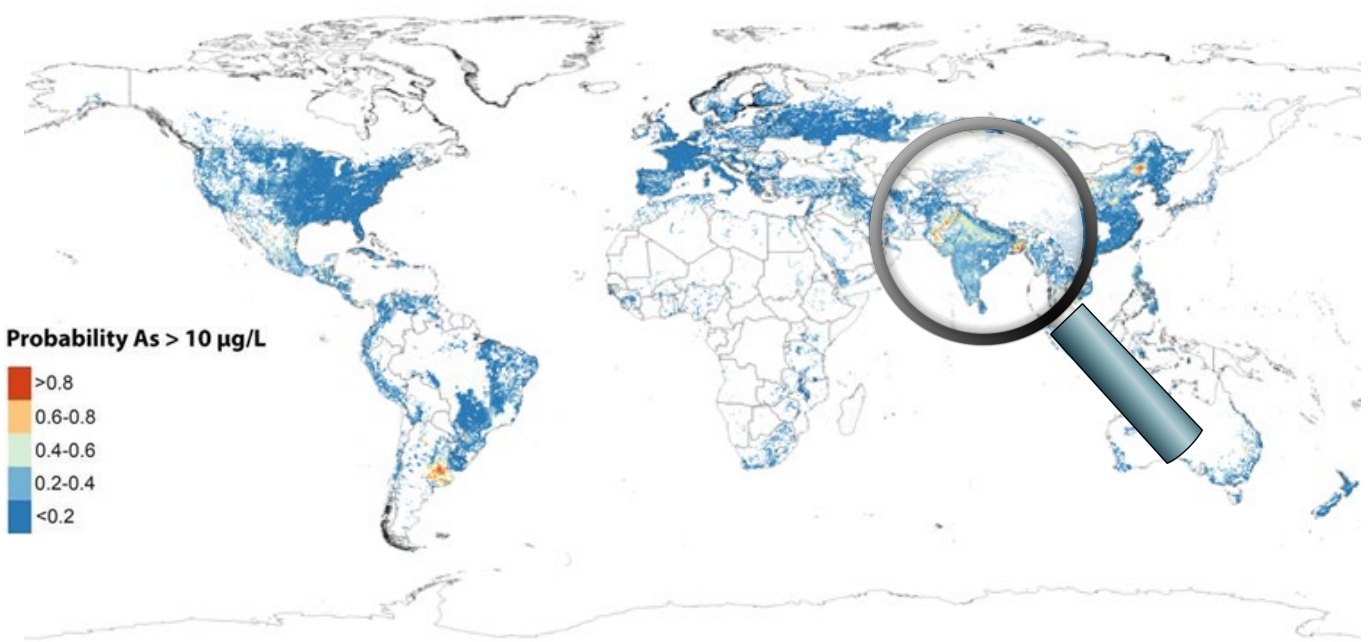
- Using saline water for irrigating crops can result in severe yield losses and decreased quality.
- Severe salinity concentrations (>450 mg/l, FAO guidelines) in surface waters likely impair the use of river water for irrigation.
- In South Asia, more than 200,000 km² (22% of the irrigated area) of agricultural land may be irrigated with saline water exceeding 450 mg/l.

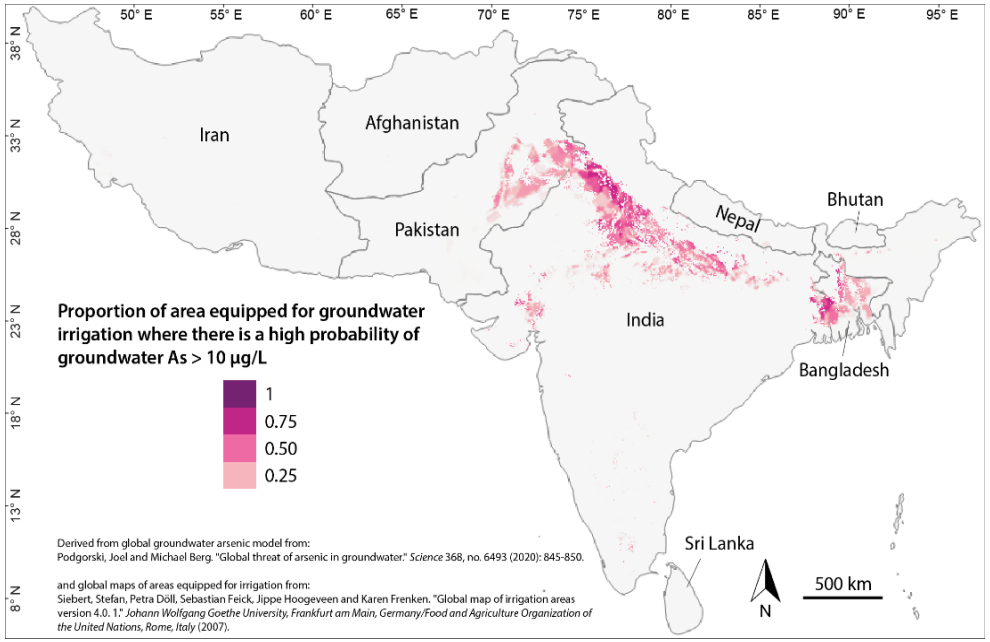




Flörke et al. (2019), WWQA (2021)

Example 3: Contaminted groundwater

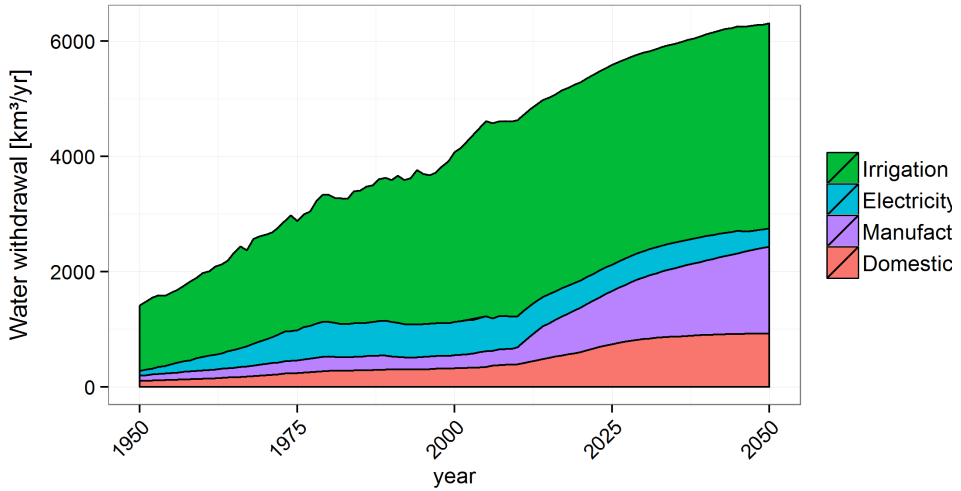




- Modelled probability of natural arsenic concentration in groundwater exceeding 10 µg/l in areas equipped for irrigation
- Heightened arsenic concentrations in water and soil lead to hazardous concentrations of arsenic in crops
- High arsenic levels in water negatively affect crop yield (e.g. rice, vegetables…)

Okorogbona et al. (2018), Podgorski & Berg (2020), WWQA (2021)

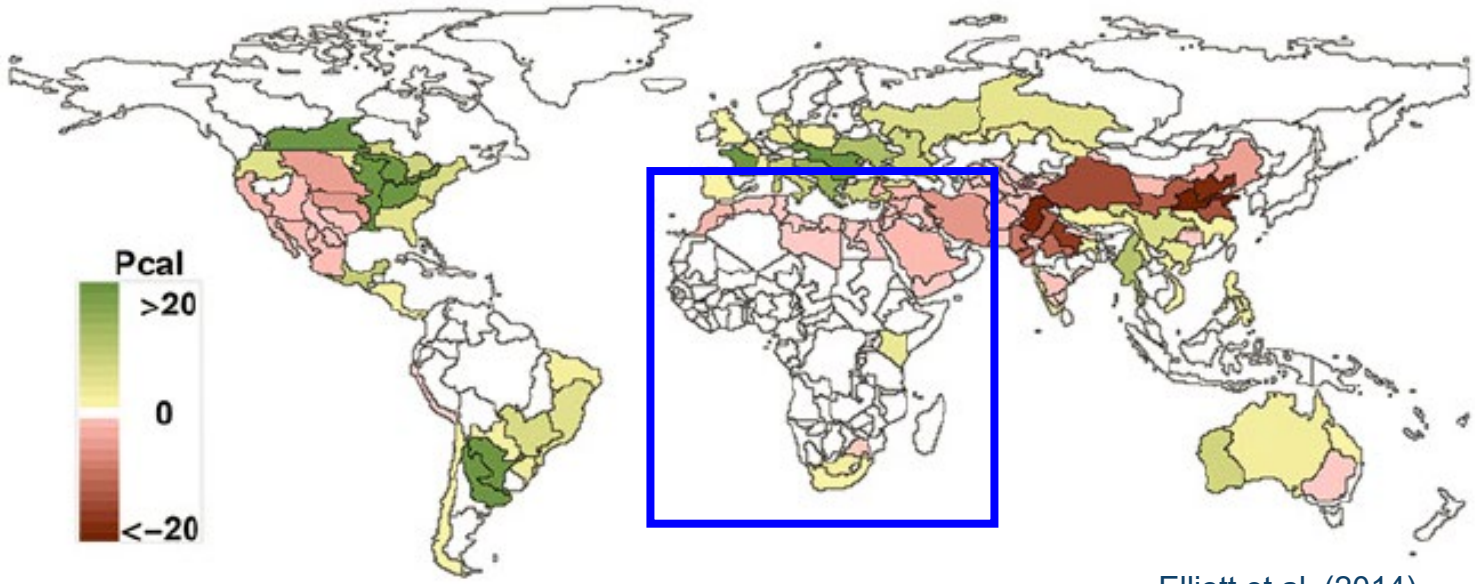
Example 4: Wastewater reuse



Flörke et al. (2013), Wada et al. (2016)

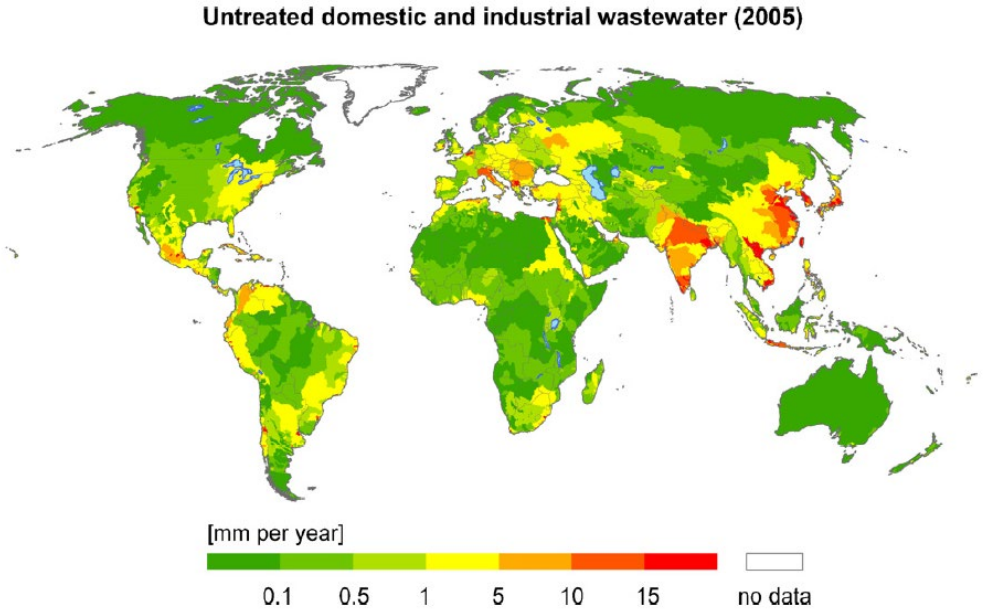
Wastewater in the context of water and food security

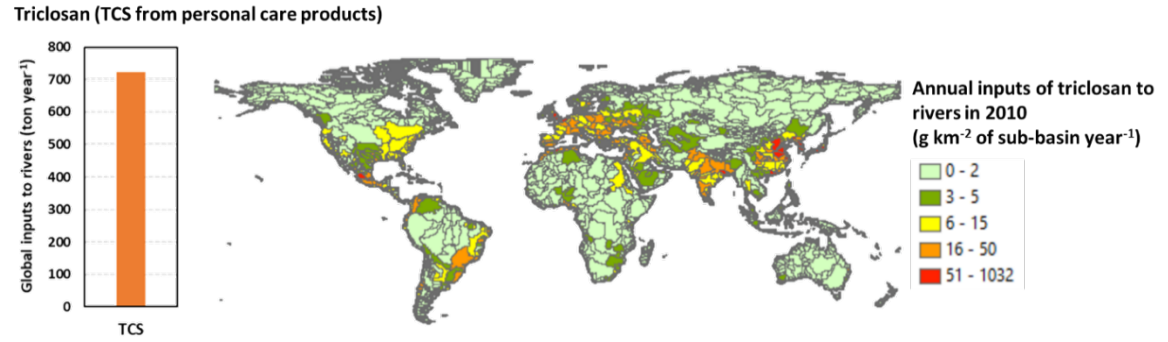
- A lack of available water for agricultural production is expected to grow
- Irrigation and freshwater limitations: Production loss: 600–2,900 Pcal (globally)

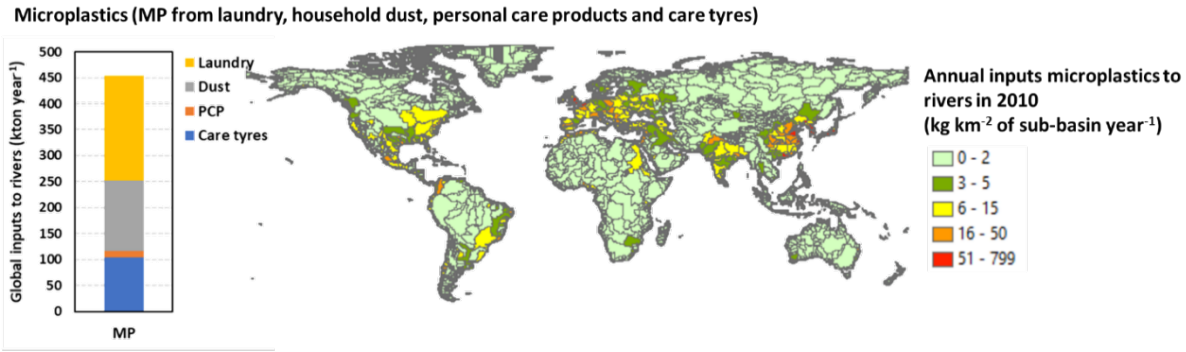


Elliott et al. (2014)

Risk to wastewater reuse







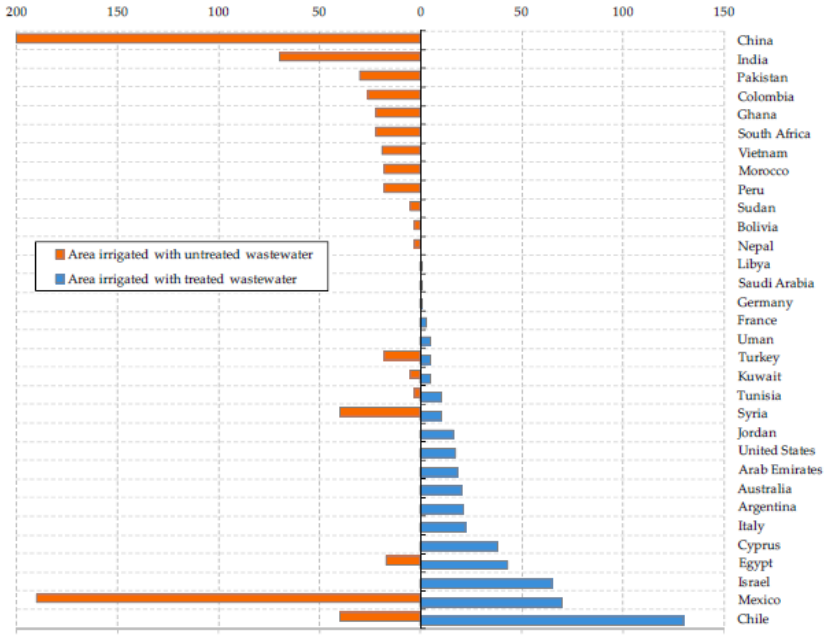


Figure 1. Reuse area in agriculture by country (thousand ha); Source: Jiménez and Asano [15].

Source: Flörke et al. (2013), Jaramillo & Restrepo (2017), Siegfried et al. (2017), van Wijnen et al. (2017), Strokal et al. (2019)

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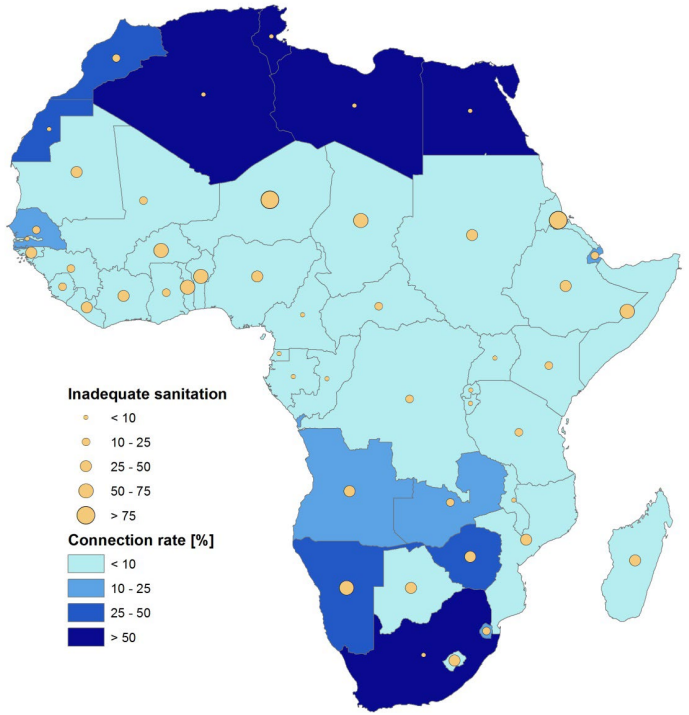
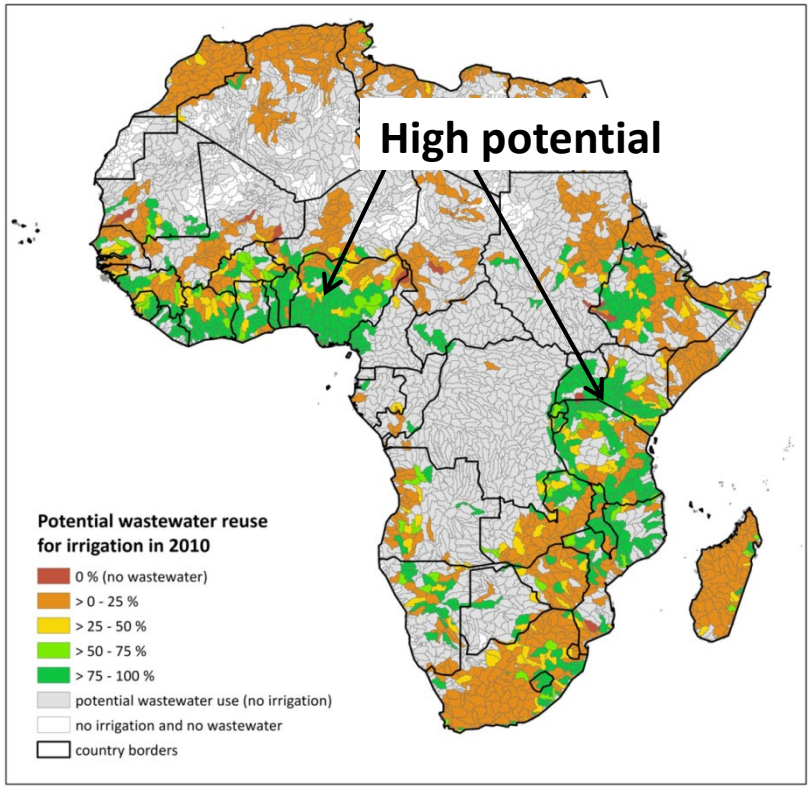
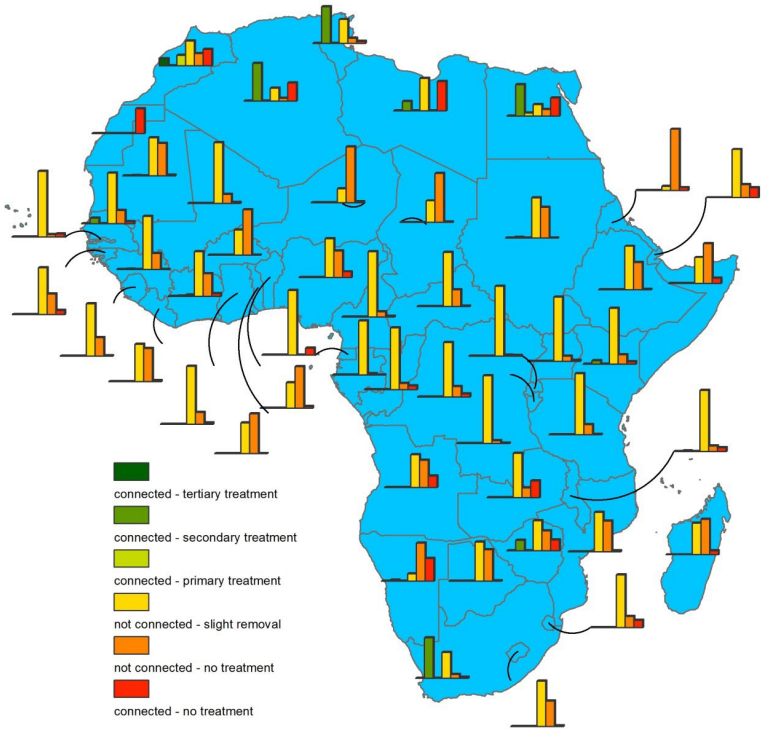
Challenges to use wastewater to compensate for irrigation water deficits



Potential for wastewater reuse





Take home messages

- Food security and food safety are already affected by reduced water quality in many regions of the world and trends of further deterioration are widespread.
- High levels of salinity, arsenic, chemicals, emerging pollutants and microplastics in irrigation water pose a risk to food security and food safety.
- First estimates of water quality impacts on food security show hotspots in north eastern China, India, the Middle East, parts of South America, Africa, Mexico, United States and the Mediterranean.
- Estimates of water quality impacts on food security reveal that over 200,000 km² of agricultural land in South Asia may be irrigated with saline water exceeding the FAO guideline of 450 mg/l and over 154,000 km² with groundwater that exceeds the WHO guideline value of 10 µg/l, respectively.
- Freshwater aquaculture production is strongly concentrated in southern and eastern Asia and seriously affected by phosphorus loading, which, in freshwaters is the major driver of eutrophication.
- Wastewater production increases, but reduction of pollution discharge by improved wastewater treatment is important to support safe use of wastewater reuse.
- Assessment of water quality impacts is difficult in quantitative terms as in-situ data and modelling data are lacking.

Thank you for your attention!

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