Sustainability of water consumption in global watersheds - current state and the effects of virtual water trade
Our water use sustainable? Exceeds capacity?

Increasing demand is threatening sustainability of water use.

=> 40% of the global population face water deficit in 2050
Globally sustainable but locally unsustainable?

Within the safe boundary at global level, some unsustainable use locally occur.

Challenges of previous PB estimation

• Overestimation of available water
  The previous estimation uses a hydrological model (LPJmL) that overestimates water flow than the actual flow, which results in optimistic estimation.

• Identification of overshooting demand
  It is not identified why overconsumption of freshwater occurs, which makes it difficult to plan counter measures.

• Responsibility of trade for the overconsumption
  Water consumption could occur in response to external demand through trade, which complicates to identify the causes of overconsumption.
Aims of this work

1. Do we step across the regional boundaries?
   Analyze current pressure and exceedance of capacity based on the realistic data

2. What are the causes of overconsumption?
   Discriminate basic and luxury demand that result in the overconsumption

3. Could virtual water trade alleviate the overconsumption?
   Evaluate the benefit and impact transfer of virtual water trade in terms of freshwater overconsumption
Estimation of overconsumption

**Definition of carrying capacities**
(monthly for watersheds)

- Available freshwater
  - WaterGap 2.2
  - Pastor et al. (2014) Hyrdrol. Earth Syst. Sci., 18, 5041-5059
  - Regional carrying capacity (RCC)
  - Environmental Water Requirement (EWR)

**Discrimination of water demand**

- Human Water Consumption (HWC)
- Basic Human Water Consumption (BHWC)
- Surplus Human Water Consumption (SHWC)
- Overconsumption of freshwater
- Dietary requirement
- Drinking/sanitary requirement
Current overconsumption (annual)

Overconsumption occurs in major watersheds (80% of the total water consumption), 396 Billion m$^3$ (around 24%) of all water consumption exceeds the boundaries.

Masaharu Motoshita, Stephan Pfister, and Matthias Finkbeiner, Environmental Science & Technology 2020 54 (14), 9083-9094 DOI: 10.1021/acs.est.0c01544
Essential or surplus demand?

Around 60% of overconsumption attributes to essential demand (mostly irrigation demand).

Irrigation demand is crucial for overconsumption.

Masaharu Motoshita, Stephan Pfister, and Matthias Finkbeiner, Environmental Science & Technology 2020 54 (14), 9083-9094 DOI: 10.1021/acs.est.0c01544
What happens after overconsumption?

Available freshwater → Regional carrying capacities → Available freshwater → Regional carrying capacity (RCC) → Environmental Water Requirement (EWR) → Human Water Consumption (HWC) → Potential impacts on biodiversity and ecosystem services

• Habitat loss
• Growth failure

Deprivation of water for ecosystems

=> Potential impacts on biodiversity and ecosystem services
On average, 60% of EWR is deprived in overconsumed watersheds.
The effect of virtual water trade

Irrigation for crops is the main factor of overconsumption, but crops are not consumed only domestically…

Virtual water trade alleviates 2/3 of overconsumption: 18.9 [Billion m³]

However, relatively small amounts compared with the total overconsumption: 396 [Billion m³]

In addition, globally saved but locally increased pressure of overconsumption.
Summary

• 1/5 of current water consumption exceeds the local safe operating space in watersheds

• 60% of overshoot attributes to the essential demand for human life
  Fundamental countermeasures are needed (improvement of water use efficiency, translocation of production site, the changes of crops etc.).

• Virtual trade alleviates overshoot but limited
  Virtual water trade alleviate overconsumption in some watersheds, but the amount is limited compared with the total overconsumption in the world.
Masaharu Motoshita, Stephan Pfister, and Matthias Finkbeiner (2020)

“Regional carrying capacities of freshwater consumption – current pressure and its sources”

Environmental Science & Technology 2020 54 (14), 9083-9094 DOI: 10.1021/acs.est.0c01544
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