

Sustainability of water consumption in global watersheds

- current state and the effects of virtual water trade



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Our water use sustainable? Exceeds capacity?



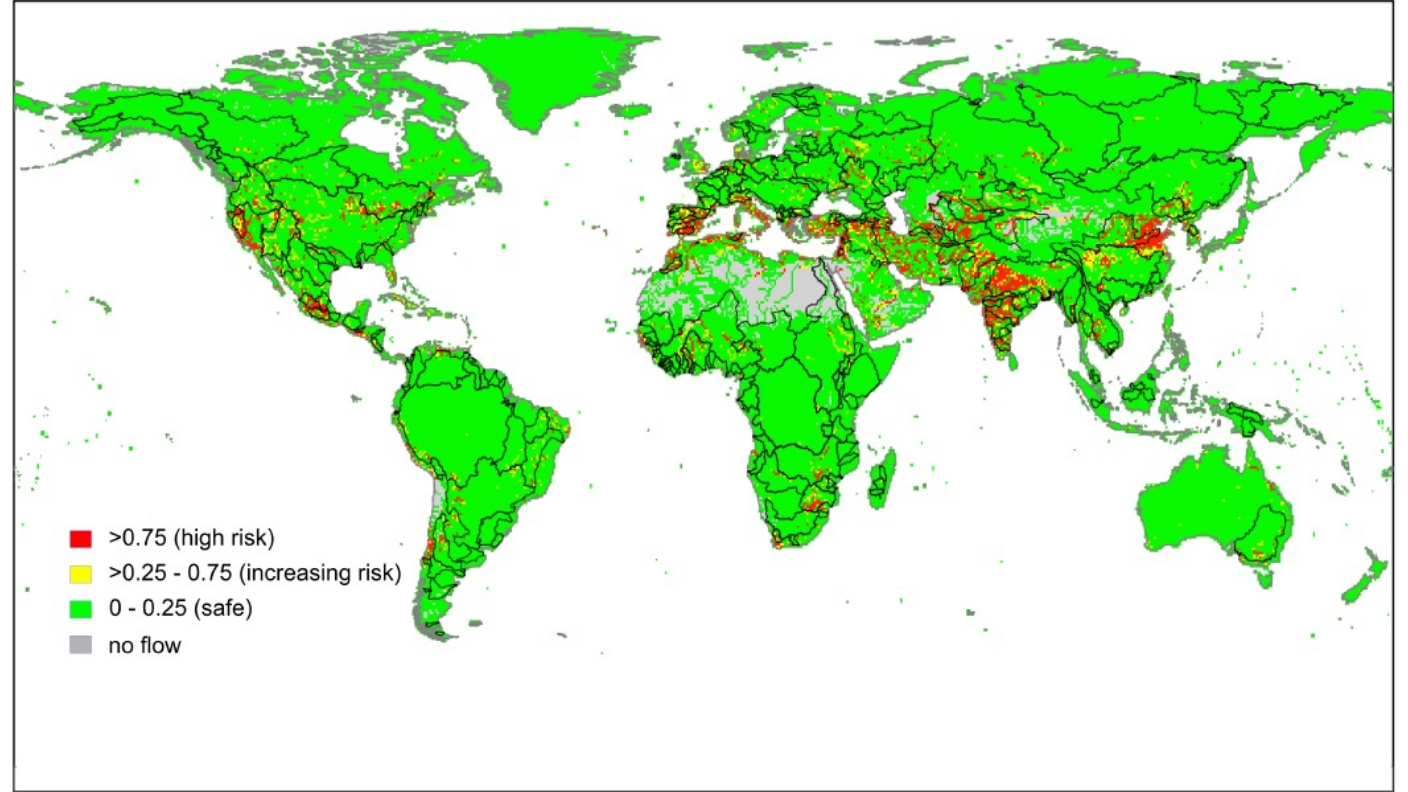
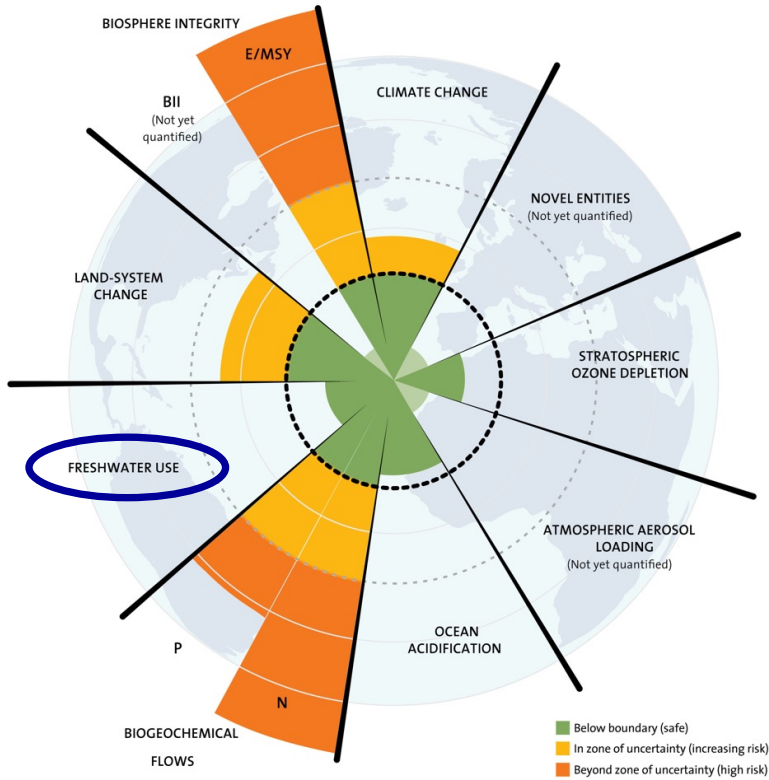
SUSTAINABLE DEVELOPMENT GOALS 17 GOALS TO TRANSFORM OUR WORLD



Increasing demand is threatening sustainability of water use.
=> 40% of the global population face water deficit in 2050

Globally sustainable but **locally unsustainable?**

Planetary boundaries



Steffen et al. 2015. Planetary Boundaries: Guiding human development on a changing planet. *Science* Vol. 347 no. 6223

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?

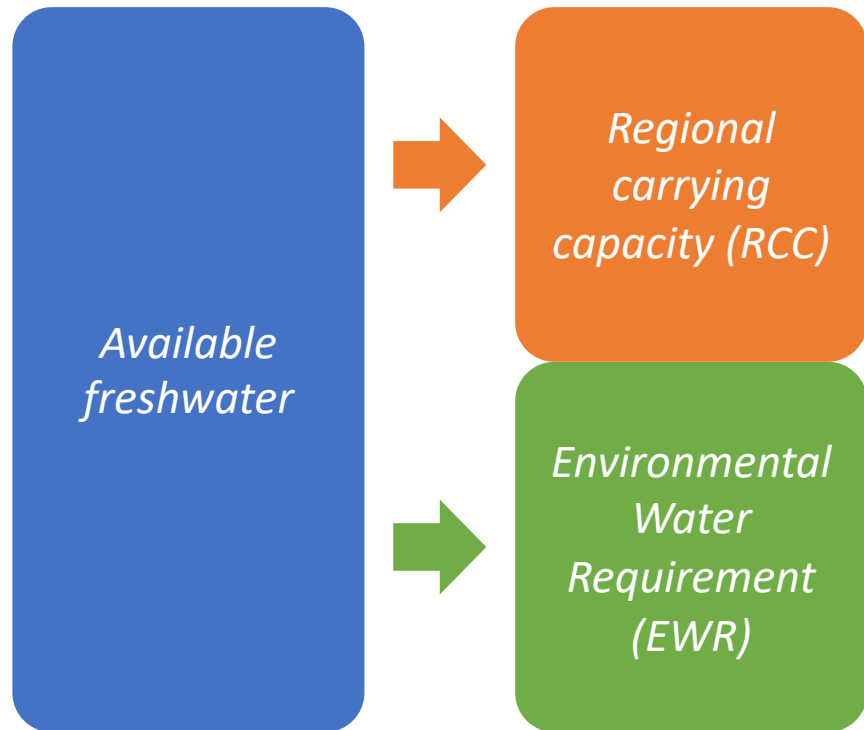
Discriminate basic and luxury demand that result in the overconsumption

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

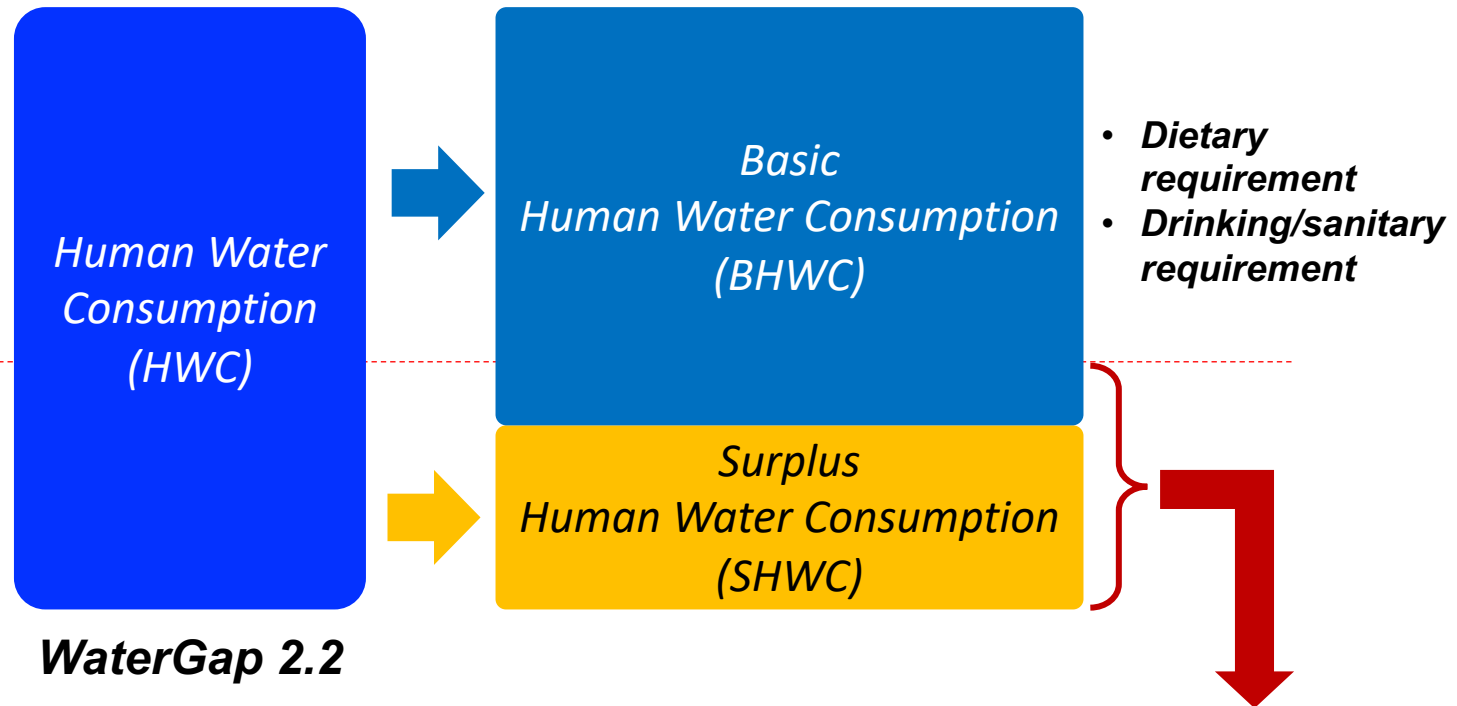
*Definition of carrying capacities
(monthly for watersheds)*



WaterGap 2.2

*Pastor et al. (2014) Hyrdrol.
Earth Syst. Sci., 18, 5041-5059*

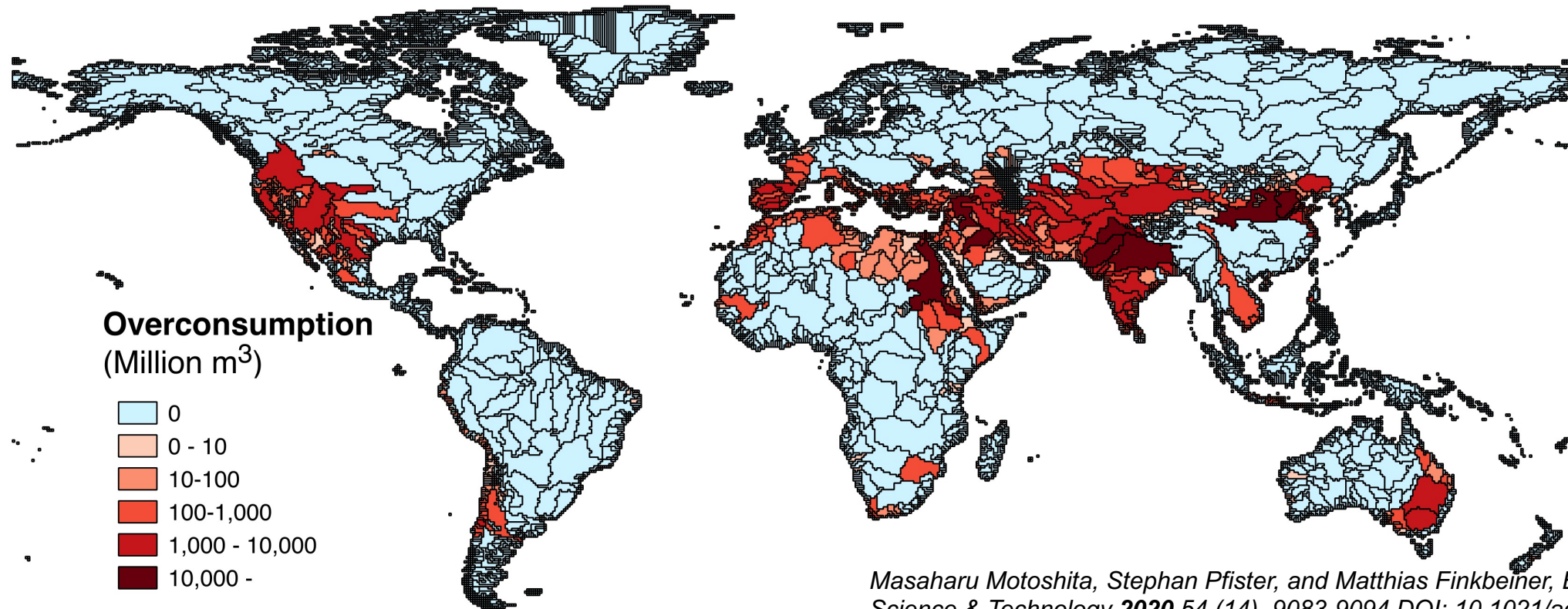
Discrimination of water demand



WaterGap 2.2

**Overconsumption
of freshwater**

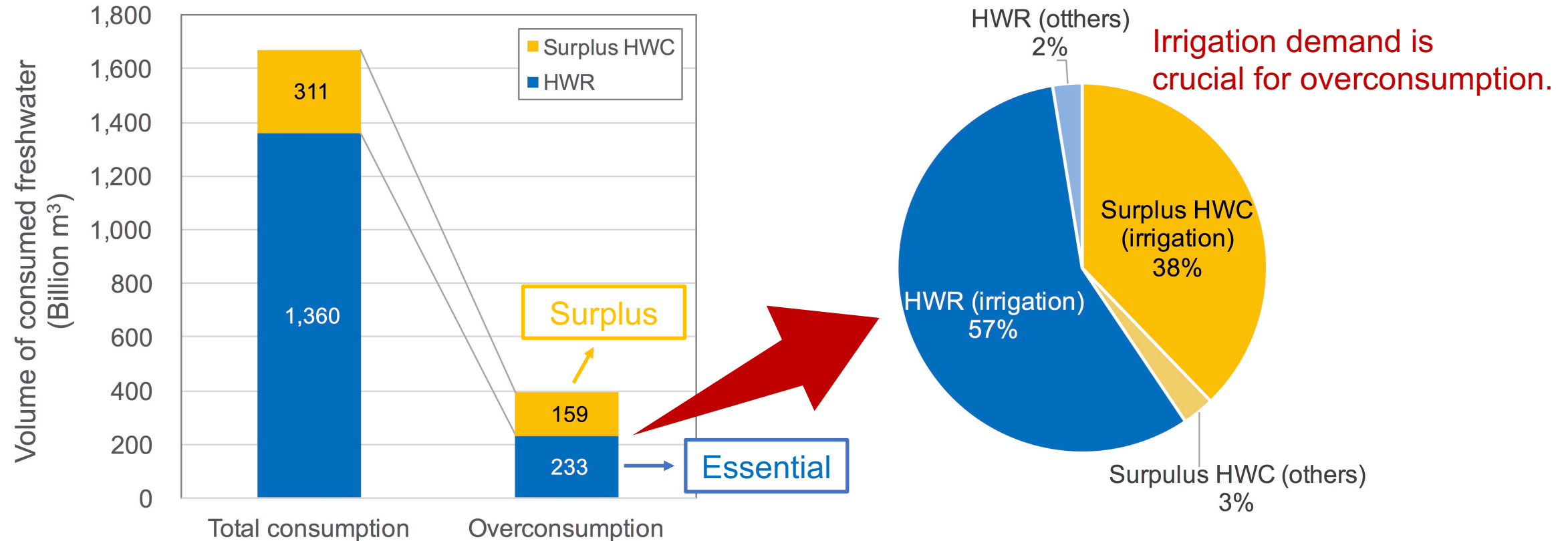
Current overconsumption (annual)



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

Overconsumption occurs in major watersheds (80% of the total water consumption), 396 Billion m³ (around 24%) of all water consumption exceeds the boundaries.

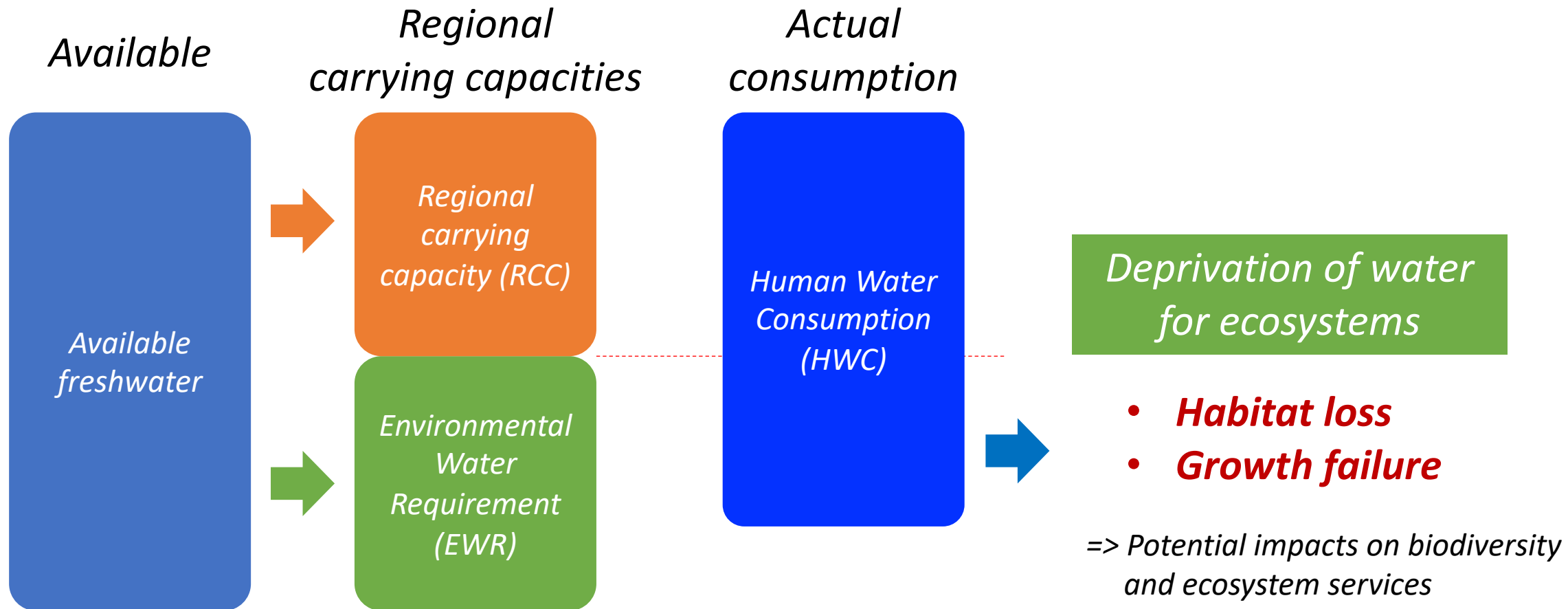
Essential or surplus demand?



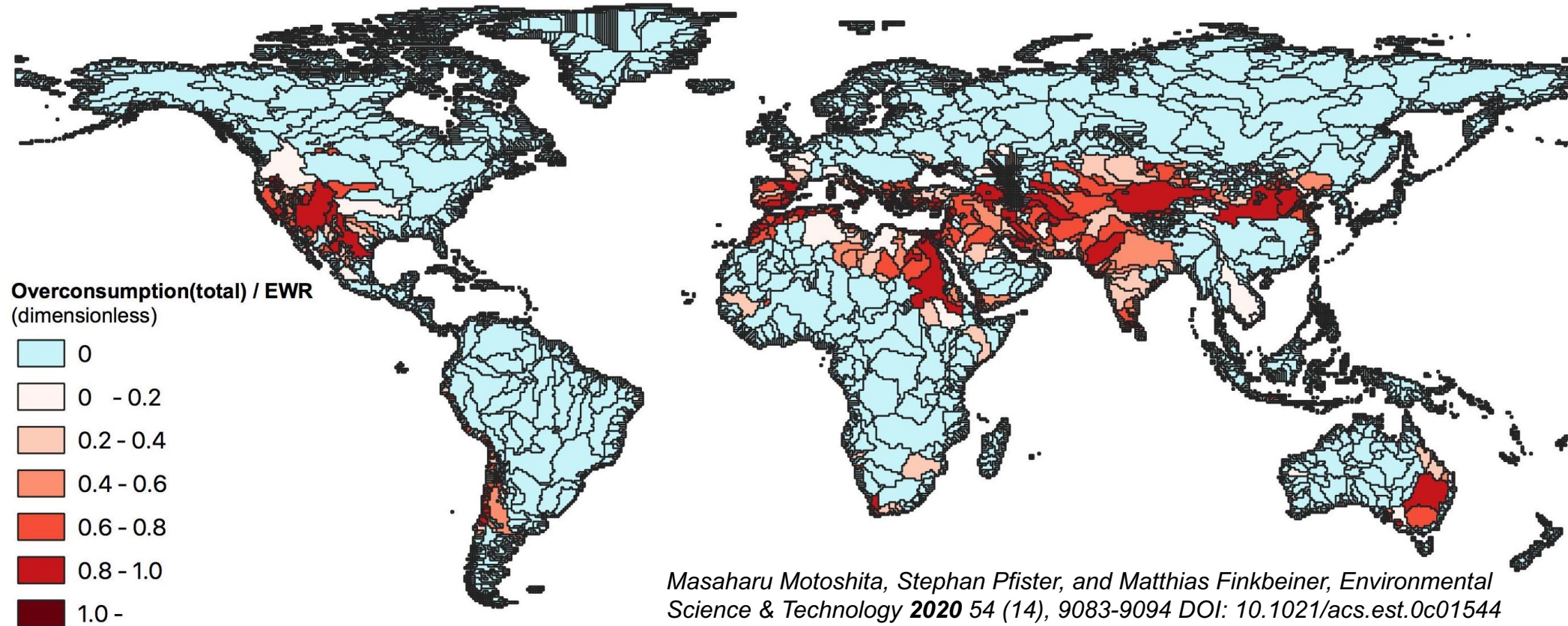
Masaharu Motoshita, Stephan Pfister, and Matthias Finkbeiner, *Environmental Science & Technology* 2020 54 (14), 9083-9094 DOI: 10.1021/acs.est.0c01544

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

What happens after overconsumption?



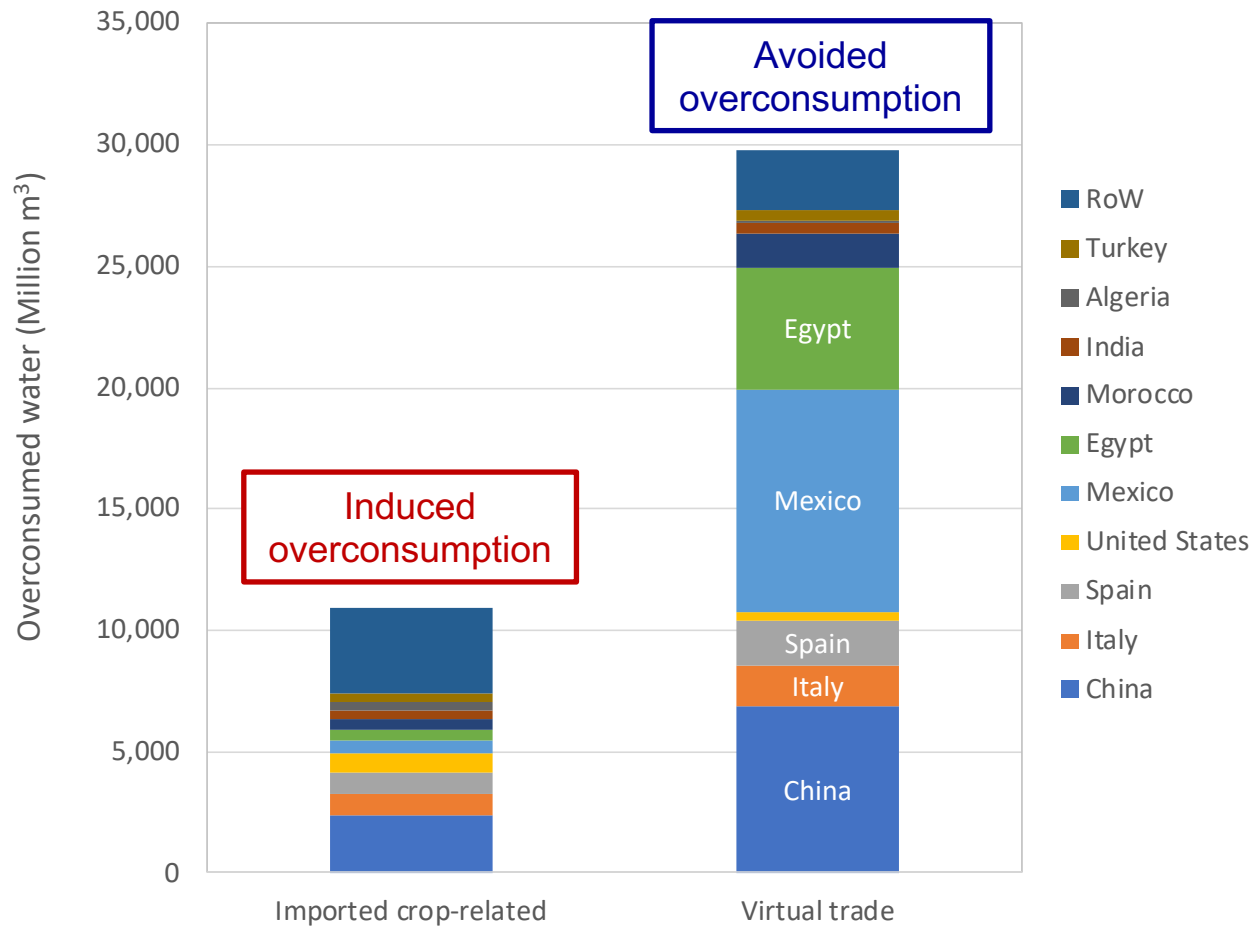
Deprivation of water for ecosystems



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.

More info. available in...

Masaharu Motoshita, Stephan Pfister,
and Matthias Finkbeiner (2020)

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

Environmental Science & Technology
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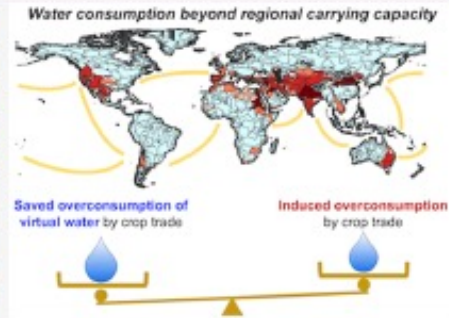
Regional Carrying Capacities of Freshwater Consumption—Current Pressure and Its Sources

Masaharu Motoshita,* Stephan Pfister, and Matthias Finkbeiner

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ABSTRACT: Sustainable freshwater management is an essential target for sustainability. The concept of planetary boundaries evaluates whether the environmental loads from humans are within the carrying capacity of the environment at a global level, while the region-specific assessment of carrying capacities of freshwater consumption can complement the global-scale sustainability assessment by shedding light on regional sustainability. We show that 24% of the total freshwater consumption exceeds the regional carrying capacities based on spatially and temporally explicit analysis (monthly data for around 11 000 watersheds). Although 19% of the current total freshwater consumption is determined as “luxury consumption” beyond basic needs, approximately 60% of the exceedance is attributed to basic needs of freshwater for sustaining human life. International trade alleviates the overall pressure on carrying capacity by approximately 4.8% (18.9 billion m³) at a global level through virtual water trade; however, several producer countries demonstrate additional overconsumption beyond the regional carrying capacities, while importer countries that can do so mitigate overconsumption. Appropriate irrigation water management and the location of crop production are the keys to maintain our freshwater consumption levels within the regional carrying capacities on a global scale. However, measures that necessitate the consideration of watershed-specific environmental and economic conditions are desirable.



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