LETTER

Reply to Ridoutt and Huang: From water footprint assessment to policy

According to Ridoutt and Huang (1), "environmental relevance must be taken into consideration if water footprints are to inform wise decision making and policy development." Indeed, reduction targets regarding water footprints (WFs) within catchments should be formulated on the basis of relative water scarcity per catchment, because local environmental impact of water use is generally larger when scarcity is higher. In many river basins, the blue WF exceeds blue freshwater availability, causing substantial environmental impact (2). However, local environmental impact is only one of a range of factors to be considered when prioritizing options for WF reduction (3). Other relevant factors are global sustainability, social equity, and economic efficiency.

The key issue concerning humanity's WF is that the world's available freshwater resources are limited, so that it is important to quantify how available water volumes are appropriated: for producing certain commodities, for certain people. Because water-intensive commodities can be traded internationally, wise allocation of freshwater resources to alternative purposes is a question with a global dimension. Water-abundant areas often show low water productivities (tons per cubic meter) and thus large product WFs (cubic meters per ton). Even though local environmental impact of water use can be small, one would be mistaken to leave these areas out of the scope of water policy. An important component of the solution to overexploitation of blue freshwater resources in water-stressed catchments is to increase water productivities (reduce product WFs) in water-abundant areas (3). Particularly the efficient use of the world's green water resources in rain-fed agriculture can help to reduce the need to consume blue water resources (4). A mere focus on reducing WFs in water-stressed catchments displays a limited perspective on the question of what is globally sustainable and efficient water use.

WFs need to be seen from the perspective of equity as well. By comparing the WF of consumption for different nations, we showed that some people consume and pollute more freshwater than others (5). The fact that US consumers have a WF per capita 2.6 times larger than people in China and India justifies a debate about equitable appropriation of freshwater resources. The world's spatially distributed freshwater resources are accessible from anywhere through trade in water-intensive commodities. The widespread inefficient use, overexploitation, and pollution of water must be a concern for all that have a water-intensive consumption pattern, not only for those that directly depend on the areas where environmental impact of water use is greatest.

We acknowledge that reducing the aggregate WF in environmentally stressed catchments deserves priority (3), but given the competition over the globe's freshwater resources, increasing water productivities (lowering product WFs) in nonstressed basins can be an instrument to reach that goal. Priorities to reduce WFs of specific products, WFs of nations as a whole, or WFs within specific catchments need to be formulated in the context of a variety of considerations, including local environmental impact, global sustainability, equity, and economic efficiency. In addition, decisions on WF reduction need to be embedded in policy that considers the use and allocation of other finite resources as well.

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LETTER

Environmental relevance—the key to understanding water footprints

Hoekstra and Mekonnen (1) offered a comprehensive assessment of global water use from the perspective of national production, consumption, and international trade. This study highlighted the often neglected fact that it is the demand for everyday goods and services that places the most pressure on the world's freshwater systems. As such, strategies based on sustainable consumption and production are needed to reduce humanity's burden on freshwater and to complement those strategies that operate at the watershed or water resource level.

That said, environmental relevance must be taken into consideration if water footprints are to inform wise decision making and policy development. Water use in a region of water abundance does not have the same potential to impact human well-being and ecosystem health as water use in a region of water stress. Hoekstra and Mekonnen (1) identified the need to address inefficient water use. However, investments to improve water use efficiency will be most beneficial if priority is given to implementation in water-stressed regions.

Water footprints that do not take environmental relevance into account have the potential to misinform and motivate behaviors that potentially conflict with the goal of reducing pressure on freshwater systems. Hoekstra and Mekonnen (1) highlighted bovine meat consumption as one of the factors explaining variation in the water footprints of nations. Elsewhere Mekonnen and Hoekstra (ref. 2, p. 413) used the same kind of virtual water assessment to argue that the "…water footprint of any animal product is larger than the water footprint of crop products with equivalent nutritional value." However, by our reasoning, livestock raised on nonarable land and without irrigation have a negligible impact on water resources (except perhaps through erosion and sedimentation if overgrazing is permitted), despite making a substantial contribution to global food production. To replace these livestock products with crop products produced elsewhere would create additional pressure on both land and water resources. Globally, the majority of beef cattle are raised in nonirrigated mixed farming and grazing systems (3).

The need to include environmental relevance in water footprint calculations is most critical when considering large countries where variation in local water stress can be extreme. In China, the virtual water content of wheat grown in the highly water-stressed northern Huang basin is 800 $m^3 \cdot$tonne $(t)^{-1}$, compared with 1,031 $m^3 \cdot t^{-1}$ in the water-rich southern Chang basin (4). However, these statistics, of the kind used by Hoekstra and Mekonnen (1) and that suggest a greater water efficiency of wheat production in the north, disguise the fact that wheat production in the north is highly dependent on irrigation abstracted from highly stressed systems.

The need to reduce humanity's water footprint does not arise from an absolute shortage of freshwater in the world. It is the result of the current pattern of freshwater use, which is greatly skewed toward highly stressed watersheds (5). Environmental relevance is the key to understanding water footprints. This issue is why the international water footprint standard, in development by the International Organization for Standardization (ISO 14046), includes this relevance as a core principal.

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