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H₂O ≠ CO₂: framing and responding to the global water crisis

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1. Introduction

Our planet is in the midst of what is often described as a global water crisis. Water has been near the top of the list of the World Economic Forum's Global Risk Report since 2013. We are not on track to meet the global ambitions of the UN 2030 Agenda for Sustainable Development, whose main water targets are enshrined in Sustainable Development Goal (SDG) 6 (to ensure availability and sustainable management of water and sanitation for all) (UN 2018).

Meanwhile freshwater biodiversity is declining twice as rapidly as its terrestrial and marine counterparts (Tickner et al 2020). Freshwater ecosystems, like our global atmospheric commons, have been exploited and neglected for too long, and this is reflected in both water and a stable climate being undervalued by economic markets (Garrick et al 2020). Climate change will likely exacerbate water crises and further threaten human security, particularly in developing countries (UNESCO/UN-Water 2020). Indeed, there are numerous overlaps between climate change and water insecurity, arguably the two most important environmental crises the world must face in the coming decades.

However, we argue that borrowing from the climate change mitigation playbook will not work for water and may distract from more effective solutions. The water crisis is multi-dimensional—the same place can suffer from too much or too little water in the same year, and scarcity is a function of not just physical water quantity, but also quality, timing, and access. Threats to freshwater biodiversity are more complex and in some places are being exacerbated by attempts to improve human water security. Therefore, applications of concepts such as planetary boundaries, footprints, and offsets in the water context can bias actions and investment into proposed solutions that are poorly matched with the actual problems on the ground. We explore these mismatches and propose an alternate framing that puts context-based freshwater health at the center of water security.

2. Planetary boundaries and global goals

Climate change is finally garnering sustained global attention, with national and local governments making binding commitments to reduce emissions, and everyone from individual citizens on up to multinational corporations taking tangible steps to decrease global greenhouse gases (GHG) emissions. These actions make sense because climate change can be reduced to a single, uni-dimensional global threat (GHG concentrations too high), goal (stay within 1.5 °C), and linear thinking (reduce GHG emissions). A unit of emissions reduction confers benefits everywhere (and, by extension, cannot be tied to anywhere). For this reason, it is both logical and pragmatic to determine a 'planetary boundary' for the climate system, and to analyze and understand how carbon is embedded in our economies and everyday lives.

Water security is similarly a topic of global concern, with increasing attention to the billions of people still lacking adequate access, climate change's potential to exacerbate both floods and droughts, and the systemic risks that multinational corporations and investors face as a result. But this global framing masks the fact that water is and always has been primarily a local issue (Hering et al 2015); in effect, the global water crisis is a mosaic of local and regional crises with unique sets of circumstances. This does not mean that water crises are not international. There are many examples of transboundary conflicts arising over shared water sources, but the boundaries are still fairly defined in the physical and spatial sense and can be assessed at a basin or sub-basin scale.

As such, there is no perfect freshwater analog to the climate’s planetary boundary of 400 ppm of CO₂. A recent study (Gleeson et al 2020) proposed a revision to the original planetary boundary for water, recommending its partition into segments or ‘sub-boundaries’ of the hydrologic cycle and suggesting that global methods for calculating sub-boundaries can be scaled to particular geographical. This was in part a recognition that the planetary
boundary as originally conceived had failed to take hold within water research and management communities. Another study (Zipper et al 2020) built on this idea of sub-boundaries and scaling, proposing an estimation of fair shares of the global safe operating space and definition of a ‘local safe operating space’. The most water-stressed regions of the world are already acutely aware of this need because freshwater resources are so unequally distributed. Defining such limits in a top-down manner, or apportioning them across the globe, has limited utility.

3. Footprints and offsets

The idea of a global boundary and thus shared responsibility lends credence to another concept with carbon parallels: water footprint assessments. Like planetary boundaries, the water footprint concept has intellectual appeal and offers a handy indicator for a complex topic. A water footprint accounts for ‘blue’ water (sourced from surface or groundwater), ‘green’ water (precipitation and runoff used directly by plants) and ‘grey’ (water needed to assimilate pollutants) with a goal of providing information on volumetric water use and pollution from the perspectives of consumers, supply-chains and products, or even specific geographies (Hoekstra 2017). This has spurred discussion of the virtual or embedded water in products and the possibility of using the information to shape policy (e.g. on agricultural production and international trade). However, the concepts of virtual water and water footprints overlook scarcity values, opportunity costs, local impacts on the environment, livelihoods, and human health, and therefore provide little of practical value to decision makers (Wichelns 2017).

Proponents of water footprint assessments do acknowledge the need to contextualize volumetric footprints in a local setting (Hogeboom 2020), and the lifecycle assessment method of calculating a water footprint attempts to do so by incorporating data on water scarcity and sometimes even modeling impacts to human health or biodiversity (Pfister et al 2017). A recent assessment (Richter et al 2020) identified beef consumption as the major driver of river flow depletion in the western U.S. and found that rotational fallingow of cattle-feed crops could help reduce water demand. While the findings are interesting and may even induce added guilt for consuming a hamburger, the policy and management implications are unclear. Is singling out a sector that happens to be the largest water consumer in a particular place the most efficient or effective way to meet a basin’s demand-management goals? Would a consumer-led boycott of beef be more effective than, say, increasing water tariffs or revising allocations, if the end goal is to stay within a river’s ecological limits?

This focus on the water footprint of economic sectors dovetails with efforts to ‘offset’ or ‘replenish’ water, the analogue to a company or product being certified carbon neutral. Water offsetting can take a variety of forms, focusing on water quantity or quality improvements near sites of high water use, often driven by a reputational risk or regulatory requirement. Volumetric water benefit accounting (Reig et al 2019) has been proposed as a way to quantify these sorts of transactions (e.g. reducing withdrawals or runoff, increasing recharge or treatment), particularly for corporate water stewardship activities. Again, the appeal is clear and it can be an effective tool if carefully managed and embedded into a watershed’s broader freshwater health strategy. The problem is that it can create a false equivalence by reducing everything to a volumetric measure, when in reality the impacts on water from a factory are substantially different from, say, those from a rainwater harvesting project. Water is not fungible where ecosystems are concerned, nor can water offset projects be meaningfully stripped of their context and aggregated into an enterprise-level portfolio. Moreover, a singular focus on volumetric benefits can divert attention from local goals that may not fit neatly into the proposed accounting framework, like improving water access, restoring aquatic habitat, and most importantly, strengthening water governance.

4. Context-based solutions, in the context of a changing climate

The local specificity of water challenges is perhaps the most important distinction from the climate crisis. Water is inextricably linked to watersheds, ecosystems, and aquifers that dictate where it flows, with a mix of private and public, rival and non-rival uses that make it notoriously difficult to value and manage as a resource. In any given watershed, the stakeholders seeking to manage water must navigate this complexity, recognizing not just the typical agricultural, industrial, and domestic users, but also the human right to water and sanitation, its cultural significance in many places, and the needs of local ecosystems, all of which constitute non-economic tradeoffs (Sadoff et al 2020). The placement of a single dam in a river may bring benefits such as hydropower, water supply stabilization, and even recreation, but it can also disrupt fish migration and material flows, displace households, cause anthropogenic droughts or floods downstream, and trigger disease outbreaks. This hydrological diversity and complexity, and the need to integrate ecological interests with diverse social and economic issues of resource use, means it is difficult to take generalized approaches to sustainable water management.

Put simply, ‘there is no clear template for catchment management that works well everywhere’ (Flitcroft et al 2018), hence there is a pressing need for context-based solutions to local and regional water issues, and all the messiness that entails. This
is common practice for most people working on real-world water management issues, where they face challenges in obtaining stakeholder buy-in, implementing appropriate measures at the basin scale and then adaptively managing as information improves and conditions change. It still requires working across traditional ‘silos’ and so in many places, improving water governance may be a logical starting point, rather than focusing solely on more ‘measurable’ aspects such as water quantity or quality (Vollmer et al 2020). The upside to this hard work is that investments can often yield specific, tangible impacts, like improved water provision for local communities, recovery of threatened freshwater species, or farmers prepared to adapt to more erratic rainfall. We should be telling those stories rather than reducing them to simple numbers.

One of the most important story lines is around climate change adaptation. Climate change is already increasing the frequency and magnitude of heatwaves, droughts, and extreme precipitation events which will potentially trigger migration and even conflict (UNESCO/UN-Water 2020). Adaptation will often (but not exclusively) require a paradigm shift in water resource management, one that accounts for ecosystem functions and services, involves stakeholders in setting performance metrics, and explicitly explores tradeoffs under possible future hydrological and climate states (Poff et al 2016). Managing water under a changing climate will also require flexible governance and adaptive co-management, tailored to the diversity and complexity of each specific place (Finlayson et al 2017). Context-based solutions for water must also be climate adaptation solutions.

5. From water security to freshwater health

Enduring context-based solutions will require working with a wide range of stakeholders (ministries, sub-national governments, businesses, civil society) at the watershed or even local administrative scale. High-level policies can be supportive but need to be informed by a better understanding of local and regional contexts (Hering et al 2015). There are still opportunities to leverage global datasets and tools to gauge progress (Gain et al 2016), but greater investment is needed in local monitoring, which can validate global water-related data and give a more accurate and acceptable measure of what is happening on the ground. While the various targets of SDG 6 do a good job of reflecting multiple dimensions of water security, they still need to be localized (UN 2018) and augmented with additional information on ecosystem health and biodiversity. A recent study (Dickens et al 2020) highlighted key monitoring gaps that are important at the basin scale, including river connectivity, environmental flows, aggregate extraction, fisheries status, and freshwater biodiversity. These data help decision makers understand the tradeoffs they are facing in maintaining healthy ecosystems that still meet human needs, but they are rarely available as a uniform global dataset.

Meanwhile, protecting natural ecosystems, particularly forests and wetlands, can both safeguard critical carbon sinks while forestalling degradation of local water cycles (Abell and Harrison 2020). Peatlands and other tropical wetlands provide the most effective natural carbon sink on the planet, in terms of sequestration per hectare (Goldstein et al 2020). These ‘nature-based solutions’ (NbS) typically provide a suite of co-benefits that make them attractive complements to hard infrastructure, while providing local resilience for an uncertain future. And since the climate mitigation benefits of NbS are global, their overall value can be enhanced by selecting sites that also optimize for local water benefits. However, ecological restoration as a form of NbS is not a panacea—re-wetted wetlands can act as net GHG sources for decades (Meng et al 2016), and forest restoration can reduce water yields downstream (Filoso et al 2017). This further underscores the need to understand both the social and ecological context when intervening in the water cycle.

Although water security is galvanizing as a concept, it can be limiting if it strips too much complexity from the challenges at hand or constrains thinking solely to issues of water quantity and access. It may be time for a pivot to framing the challenge around freshwater health, and actions that prioritize maintaining or restoring healthy watersheds to meet diverse needs. Recognizing that healthy ecosystems are not just a stakeholder or beneficiary issue, but the foundation of water security, can create space for decision makers to not only evaluate tradeoffs but also create positive visions for the future as opposed to a narrow focus on risk reduction (Vollmer et al 2018). This does not mean a hyper focus on watersheds, either—groundwater, moisture cycling, invasive species, and hydraulic infrastructure often have regional impacts on freshwater health, and of course national water policies largely frame what is possible and prioritized at a more local level. The trick is identifying the right combination of actions that keeps watersheds within their safe operating space, and for that reason we hope to see that the talent, passion, and resources currently working on elements of global water security are directed where they can have the greatest impact.

Rather than developing more ways to measure water security globally, it will be useful to start tracking how many countries or basins are equipped to conduct their own routine monitoring and define their local safe operating space. More effort is also required to help decision makers understand the local ecological limits of their basins and explore the tradeoffs they face in supporting economic development within those limits. And instead of companies and consumers investing in offsetting their water
impact, more investment is needed to address root problems and local concerns, which may be water access, water governance, or something else. Most countries still need global support if they are to realize their goals for freshwater health, but the agenda and solutions should largely be bottom-up.

Data availability statement

No new data were created or analyzed in this study.

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Author contributions

D V led the conceptualization, original draft preparation, review and editing. I J H contributed to original draft preparation, review and editing.

Conflict of interest

Authors declare no competing interests.

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