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Making Waves: A research agenda for supporting a WASH sustainability transformations approach to climate change

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ABSTRACT

Contemporary approaches to water, sanitation, and hygiene (WASH) service resilience-building for climate change in low- and middle-income countries are often not fit for purpose. The current excessive focus on discrete, anticipated risks, such as water shortages due to dry spells and faecal contamination due to flooding, alone is unlikely to be sufficient in sustaining WASH services against future climate change. This is because broader socio-environmental impacts of climate change, such as ecosystem collapse and economic hardship, will be more consequential for WASH services. This Perspective outlines a research agenda in support of a WASH sustainability transformations approach to climate change that will contribute to realising broader societal and environmental sustainability. The proposed research agenda includes identifying 1) what WASH-related systems could be transformed and how; 2) what WASH-related systems should be transformed and when; 3) who leads and contributes to transformations; and 4) how transformations can be monitored and evaluated.

Climate change poses greater threats beyond discrete physical risks

Climate change contributes to a wide range of risks – defined as potential adverse outcomes (IPCC, 2022a) – to water and sanitation access and service delivery in low- and middle-income countries (LMICs). The number of risks to consider is extensive (Hyde-Smith et al., 2022; Nijhawan and Howard, 2022; Li et al., 2023; Ferdowsi et al., 2024). Consequently, the global water, sanitation and hygiene (WASH) sector has firmly placed climate change resilience at the centre of its programming and service delivery efforts to reduce these anticipated risks. Although shifts in donor priorities and the international aid funding landscape towards climate financing appear to be a significant driver for the sector's prioritisation of resilience-building, there is also genuine concern amongst WASH professionals for the near- and long-term impacts of climate change. The threats of these impacts truly warrant the prevailing attention.

Yet, the WASH sector's adoption of a resilience narrative to guide its efforts may be insufficient to drive the necessary change for delivering life-enabling WASH services. The sector's resilience narrative and implementation focus often emphasise addressing discrete, identifiable risks to WASH services through a risk assessment and control measure approach (such as climate-resilient water safety planning approaches). While this can be effective at reducing specific risks to WASH infrastructure and services, such as contamination of drinking water sources during flooding or stores of water running emptying during a dry spell, this type of approach often misses the more profound threats of climate change to the foundations of sustainable WASH services. This is because addressing sector-specific risks often results in only incremental adaptations that are too small in size and scale to address greater threats to socio-environmental sustainability (UNFCCC, 2024). That resilience is supplanting sustainability as the central concept in development discourse (Matthews, 2023) arguably reflects the remorseful state in which the world finds itself. It may signify an admission that the global community at large is failing to manage the planet in a sustainable way, leaving us to brace ourselves for the consequences. Although the obvious, present climate risks require immediate attention, the longer-term solutions lie in addressing the threats to the sustainability of broader socio-environmental systems that underpin WASH services.

The broader impacts of climate change on society and the environment at large have the farthest-reaching potential to undermine WASH services, even if they are not directly related to WASH. Without adequate action, the worldwide impacts of climate change will be dire and, for some regions of the world, beyond catastrophic and bordering

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on apocalyptic within this generation. Many LMICs lack the resources to maintain the habitability of their entire country against the effects of climate change (Future Earth et al., 2024). A study published in Nature predicts global heating could lead to a 23 % reduction in average global income this century, with losses disproportionately felt in poorer countries (Burke et al., 2015). Yet even this may be a severe underestimate due to the limitations of conventional economic models in accounting for complex interrelationships between earth systems and economies (Keen, 2022). The list of potential social-environmental changes due to extreme global heating is lengthy and frightening. Global hunger could skyrocket as declining crop productivity struggles to meet demand (Hasegawa et al., 2021). Between 50 % and 75 % of the global population could be exposed at times to life-threatening extreme heat and humidity, with many cities like Delhi and Hanoi each year enduring a week's worth of heat and humidity so extreme that simply being outdoors for too long would be fatal due to humans' inability to thermoregulate in such conditions (Vecellio et al., 2023). Armed conflict and asylum seeking may be significantly intensified (Abel et al., 2019; Mach et al., 2019). Hundreds of millions of people could have their homes become exposed to high tides for the first time (Kulp and Strauss, 2019). The list goes on and on.

The widespread ecological crises, social upheaval, and the ensuing economic devastation associated with these global impacts would be far more consequential for WASH service delivery than any discrete physical flood or drought risk. Armed conflicts, which one could consider a localised analogue to the impacts of climate change in regard to how they disrupt social and environmental systems, are known to cause precipitous declines in safe water and sanitation access (Als et al., 2020; Ortiz-Correa and Dinar, 2022). Against a future backdrop of climate change-driven societal collapses (Penuelas, 2023), policymakers and the public simply will not give much mind to WASH-specific risks such as preventing septic containment units from overflowing, nor will addressing such risks be tenable when the fundamental socio-environmental systems that sustain WASH services are failing. The fallouts described here are admittedly pessimistic. Even with extreme global heating, these outcomes may not come to pass. But the possibility that we reach Earth-system tipping points – thresholds at which large-scale, irreversible damage occur – is too real to ignore (Lenton et al., 2019).

What is needed to prevent the failure of systems on which WASH systems rely?

Experts across diverse disciplines and domains have delivered a consistent and unequivocal message on how to stop the global threats: our systems must be transformed (Whitmee et al., 2015; Nightingale et al., 2020; Scoones et al., 2020; Folke et al., 2021; Stoddard et al., 2021; Morrison et al., 2022). These necessary transformations could be achieved through interventions that aim to, for example, reorganize economies around improving human well-being over GDP growth, support tax reforms and investments to address power asymmetries, and transition from extractive and exploitative systems towards alternatives like sustainable farming and renewable energy (Morrison et al., 2022). However, a recent review of planetary indicators monitoring worldwide progress towards such transformation described global action to-date as only making "very minor headway" (Ripple et al., 2024). Indeed, the world's current efforts put 3 °C or more of warming – far beyond the 1.5 °C threshold that the Intergovernmental Panel on Climate Change (IPCC) considers to be a safe operating space for humanity – well within the realm of possibility (Climate Action Tracker, 2025).

What can the WASH sector do to support the realisation of these big picture transformations, many of which do not seem directly related to WASH? Transformations occur at different scales and smaller-scale transformations can accumulate to exert wider influence (Chaffin et al., 2016). Safe WASH is also foundational for most other Sustainable Development Goals (Stockholm Resilience Centre, 2016). While the WASH sector has engaged with the concept of transformation in relation to public health and gender equality, there is much more room for imagination on how a 'WASH sustainability transformations' (WASH-ST) approach could contribute to larger-scale social--environmental transformations (Carrard, 2024). A WASH-ST approach would go beyond incremental adaptations that are too small in scale and narrowly sector-specific (IPCC, 2022b) and instead pursue transformational adaptations that will support planetary sustainability (Carrard, 2024) while simultaneously addressing immediate risks to WASH services. Such transformations may, for example, support a shift in development values and priorities towards ecosystem stewardship, a reset of asymmetrical socioeconomic and gendered power relationships, and transitions to net zero emissions economies. A WASH-ST approach (the actions and processes to create change) may be just what is needed to steward transformational adaptations (the resulting changes required to thrive).

Where to start? A research agenda to inform the design of a WASH sustainability transformations approach to climate change

Research priorities are needed to help establish a starting point for the design and eventual implementation of WASH-ST approaches to climate change. This section outlines a research agenda, in the form of guiding questions, for supporting the WASH sector in evolving its thinking on tackling climate change.

Two immediate questions are: What could be transformed, and how? Various schools of thought exist on types of transformations, including those that focus on personal, cultural, institutional, political, technological, ecological, and socioeconomic changes, and the interaction of the systems across those domains (Geels, 2019). The popular Leverage Points framework posits that the power to transcend paradigms, recognising and questioning the values, goals, and worldviews that underpin systems, may be the most powerful way to start transformations (Meadows, 1999; Abson et al., 2017). This capacity can be fostered through educational processes (De La Sienra, 2017) and, in the context of WASH, has been explored through workshops at the local government level (Kohlitz et al., 2024). Approaches to relational transformations for addressing power asymmetries that make people more vulnerable to climate change, particularly with respect to gender, are well-developed in the WASH sector (MacArthur et al., 2023). WASH technologies and infrastructure, along with their management, can be transformed to support a more circular economy, reducing greenhouse gas emissions and environmental impacts while maintaining high public health standards (Carrard et al., 2024). Finally, legal frameworks to realise the human right to water can be evolved to blend in the rights of rivers and water communing statutes to allow for more sustainable and equitable water resource use under climate change (O'Donnell et al., 2024). Each of these examples – changing mindsets, building equitable relationships, shifting towards a circular economy, and institutionalising rights to water – can be implemented in ways that simultaneously address climate risks to WASH and contribute to a broader transition to a more sustainable society. Future research must deepen thinking on transformation practice and its application to WASH in ways that improve services and contribute to broader socio-environmental change.

Another key set of questions is: What should be transformed, and when? Not all WASH-related systems require fundamental changes at present. For example, in some country contexts, it may be more beneficial to integrate climate risk management processes into ongoing WASH governance-strengthening efforts (Water for Women, 2025) rather than transform how WASH services are governed. Transformation becomes necessary when adaptation limits, thresholds beyond which incremental adjustments are insufficient to prevent intolerable risks, are reached (IPCC, 2022b; UNFCCC, 2024). Some systems essential for safe WASH services may already be untenable, others may become so under future climate conditions, while some may only require improvements within their existing structure. Further research is needed to help WASH

decision-makers identify each case. However, in many instances, the need for transformation will be subjective. The research community must engage with diverse perspectives and values to guide decision-makers on when transformations should be implemented.

This raises a critical question that is all too easy to overlook: Who leads and contributes to the WASH transformation agenda? An overly prescriptive approach, dominated by a singular perspective, risks co-opting transformation discourse to justify business-as-usual practices (Blythe et al., 2018). It can also shift the burden of responding to climate risks onto vulnerable populations, overlook socially differentiated vulnerabilities to climate change, exclude practical non-transformative approaches, and avoid engaging with issues of power and politics (Blythe et al., 2018). Pluralizing research and practice on WASH-ST, while engaging diverse stakeholders – including communities, rights-holder organizations, and governments – can help prevent the emergence of a hegemonic perspective (Blythe et al., 2018; Nightingale et al., 2020). Transdisciplinary approaches are particularly well-suited to fostering pluralism in WASH sustainability efforts (Carrard et el., 2022). However, the urgency of climate change demands swift action. Governments have a legitimate mandate to act and, in some cases, may be the only entities capable of mobilising stakeholders and resources quickly enough. Hence, governments must take responsibility for leadership. At the same time, practitioners and researchers must find effective, legitimate, and expedient ways to facilitate knowledge exchanges on the topic of transformation even as the sector still grapples with its meaning.

A final question for consideration is: How can a WASH-ST approach be monitored and evaluated? This begs another question: What constitutes transformation in the context of WASH and climate change? The IPCC defines transformational adaptation as “Adaptation that changes the fundamental attributes of a social-ecological system in anticipation of climate change and its impacts” (IPCC, 2022a). However, how fundamental changes and their desired outcomes are defined and measured will depend on the specific context and the nature of the transformation being examined. For instance, metrics relating to resource control, agency, critical consciousness, social structures, and wellbeing for assessing gender-transformative WASH interventions have been developed (MacArthur et al., 2024) and subsequently adapted to incorporate climate impact considerations (UTS-ISF, 2025). Further research is needed to develop robust monitoring and evaluation frameworks for other forms of transformational WASH adaptations, including their contributions to resilience at different scales (Willetts et al., 2024).

Taken together, these research priorities emphasise the urgent need to implement just, pluralistic WASH-ST approaches. The challenge lies not only in securing research investments and carrying out the research to inform policy and practice but doing so at a scale that aligns with the pace and magnitude of climate change impacts. As the WASH sector grapples with these complex questions, it must simultaneously strive to contribute meaningfully to broader socio-environmental transformations that extend far beyond its traditional remit.

Conclusions

- Current climate resilience discussions in WASH are overly focused on managing specific risks, neglecting threats to the systems underpinning sustainable services.
- Managing discrete risks is important but must be combined with solutions addressing broader, severe climate impacts.
- This is not a call to revert to business-as-usual sustainability models, but instead to transition to transformational approaches that account for emerging, unprecedented threats.
- A more ambitious WASH-ST approach is needed across programming, service delivery, research, and policy.
- The research community must develop pluralistic frameworks to guide necessary transformations within and beyond WASH.
- Currently, there is a lack of clear guidance on operationalising transformation, which must be urgently addressed to enable an effective climate change response.

CRediT authorship contribution statement

Jeremy Kohlitz: Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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