

Global Water, Sanitation, and Hygiene Approaches: Anthropological Contributions and Future Directions for Engineering

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Abstract

Anthropologists contribute key insights toward a comprehensive understanding of water, sanitation, and hygiene (WASH) as a multidimensional, multiscalar, and culturally embedded phenomenon. Yet, these insights have yet to be sufficiently operationalized and implemented in WASH development and wider WASH access-related paradigms. Ensuring WASH security requires a comprehensive approach to identifying both human health risk and environmental impact of WASH-related programs and strategies. It requires an understanding of how sanitation is integrated into households and communities and how individuals within particular cultural contexts practice sanitation and hygiene. This work facilitates that goal by outlining the major contributions of anthropology and allied social sciences to WASH, as well as outlining key considerations for future work and collaboration. We identify six major themes that, if applied in future engineering approaches, will more equitably integrate stakeholders and multiple vantage points in the successful implementation of WASH projects for marginalized and diverse groups. These include a critical understanding of previous approaches, culturally aware interventions, capacity building that considers (un)intended impact, co-created technology, collaboration between fields such as anthropology and engineering, and challenge-ready initiatives that respond to historic and emergent social and environmental inequity.

Keywords: appropriate solutions; interdisciplinary; sustainable development; transdisciplinary

Introduction

ANTHROPOLOGISTS AND OTHER social scientists contribute key insights toward a comprehensive understanding of water, sanitation, and hygiene (WASH) as a multidimensional, multiscalar, and culturally embedded phenomenon. Yet, these insights have yet to be sufficiently operationalized and implemented in WASH development and wider WASH access-related paradigms. Ensuring WASH security requires a comprehensive approach to identifying both human health risk and environmental impact of WASH-related programs and strategies. It requires an understanding of how sanitation is integrated into households and communities and how in-

dividuals within varied cultural contexts practice sanitation. Moreover, there are psychological and social outcomes from inadequate (e.g., unsafe, insufficient, unacceptable, inaccessible, and unaffordable) WASH that lead to feedback loops and complex relationships with other insecurities (e.g., food insecurity see Brewis *et al.* [2020]; Workman *et al.* [2021]) and health outcomes overall.

In contrast to viewing culture as a “barrier” to overcome, social scientists see WASH systems as rooted in culture and interconnected with multiple social systems. While problems with access, for instance, may potentially be caused by wider sociocultural and environmental inequities, they also, and perhaps more importantly, may cause that inequity to develop or deepen. As such, marginalized communities and individuals often bear the brunt of inadequately scoped or contextualized WASH programs, with negative health-related, economic, and/or environmental outcomes. This article as a whole provides many examples of such impacts, and shows how these impacts often fall, along racial, class, and/

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or gendered lines. Calls for more human-focused research on WASH experiences are often noted in engineering literature. As evidenced by the results from the recent Shine and WASH Benefits clinical trials (Humphrey *et al.*, 2019; Pickering *et al.*, 2019), there is a need for more qualitative/local perspectives and a more comprehensive understanding of what WASH entails, that is, a more “transformative” WASH. The uneven success of over fifty years of development initiatives indicates the need for sophisticated, integrated approaches to improving health and well-being through a better understanding of sociotechnical and socioenvironmental relationships. We encourage scholars in engineering and related disciplines to engage social science, and especially anthropological approaches, which effectively theorize, consider, measure, and evaluate impacts of WASH initiatives within global and cultural contexts. This engagement can forward holistic approaches to engineering work and deepen engineers’ attention to multiple factors that may be preventing equitable WASH access in marginalized communities. This work facilitates that goal by outlining the major contributions of anthropology to WASH, as well as outlining key considerations for future work and collaboration.

This “critical review” of anthropological and allied approaches to WASH, collated by the interdisciplinary authorship team, provides both an overview of key works within this realm as well as springboards a distinct theoretical perspective that is poised to spur new thought and practice within the WASH field, as presented in the “C’s” sections of this work (see Grant and Booth [2009] for an overview of this review technique, also utilized in Flotemersch *et al.* [2019]). The goal is not to serve as a final arbiter of the contributions of anthropology to the field of WASH, but rather provide a critical discussion of the distinct import of anthropological approaches to the practice of engineering, especially for marginalized groups.

Engineering Approaches and Contributions to Global WASH

Engineers, especially from the fields of environmental engineering and civil engineering (and often working alongside public health professionals), have historically focused efforts on advancing environmental sustainability in developing regions of the world through WASH interventions (Mihelcic *et al.*, 2017). These contributions have historically focused more on water and sanitation technologies and interventions than on hygiene. The “community of practice” in WASH includes engineering practitioners in government and nongovernment agencies, local utilities, and on-the-ground practitioners, who have historically been at the forefront of many of these interventions (e.g., the Sustainable Sanitation Alliance [SuSanA] network). Many engineering contributions have been made to the “gray” literature in the form of books and manuals (e.g., Davis and Lambert, 1995; Mara, 2004; Tilley *et al.*, 2014), briefing notes, and guidelines (e.g., WHO, 2017, 2018) that highlight “best practices” for implementing WASH interventions. Engineering scholarship also includes reviews of the literature on WASH in emergency settings (Brown *et al.*, 2012), the ability of WASH systems to reduce pathogens (Feachem *et al.*, 1983; Rose and Jimenez, 2019), and the design of WASH systems using appropriate technologies (Mihelcic *et al.*, 2009; Murphy *et al.*, 2009; Thye *et al.*,

2011). Engineering design competitions, such as the “Reinvent the Toilet” challenge sponsored by the Bill & Melinda Gates Foundation, resulted in the development of new WASH technologies, often targeting the recovery of nutrients, energy, and recycled water, which were intended to serve low-income urban communities (e.g., Bair *et al.*, 2015; Larsen *et al.*, 2015). Engineering scholars have also developed decision support tools for choosing appropriate sanitation technologies or evaluating the sustainability of WASH systems (McConville and Mihelcic, 2007; McConville *et al.*, 2014; Fecal Sludge Management Toolbox, <https://www.fsmtbox.com>).

Quite a few publications on topics related to engineering for development have been completed by scholars in the global North with the intention of serving communities in the global South, often using approaches that are technology centric. Notably, the Science, Technology, Engineering and Mathematics (STEM) fields have been critiqued for their homogeneity, with research and practice aiming to draw more women and underrepresented minorities onto the engineering pathway or pipeline (Burke and Mattis, 2007; Borman *et al.*, 2010; Douglas, 2015; Eastman *et al.*, 2019). However, evidence and experience indicate that WASH challenges in WASH-insecure communities are not solvable by technology fixes alone, leading to the introduction of a more participatory, transdisciplinary, and community-centered approach to research, development, design, and application of global WASH approaches (Kennedy-Walker *et al.*, 2014). In fact, the integration of culture, perception, and behavior with advances in science and technology has been described as one of the grand challenges associated with engineering approaches to global WASH (Mihelcic *et al.*, 2017). The growing recognition of the importance of contributions from scholars in the field of anthropology and in other allied social science disciplines to global WASH research is a welcome and needed development. Anthropology is not the only social science that is situated to offer theoretical and practical leadership for achieving more equitable engineering initiatives to support marginalized populations. We assert, however, that anthropological practice, method, and perspective are particularly well suited to support engineering for marginalized communities for the reasons articulated throughout this article.

Anthropological Contributions to Global WASH

Anthropological and allied social science research on WASH have historically focused more on water than on sanitation or hygiene. Present research on sanitation and hygiene falls within three genres: (1) critiques of development and development policy; (2) discussions of water and sanitation infrastructure; and (3) health impacts from lack of water and sanitation. Anthropological research on the human dimensions of WASH draws heavily on human geography and public health. Within anthropology, research on WASH draws from cultural and biological anthropology as well as specialized subfields such as environmental and medical anthropology. We outline anthropological and broader social science work within these spheres that may apply to transdisciplinary research and practice. Notably, these WASH-specific literatures build from major categories of thought within anthropology and allied fields, namely, the anthropology of development (e.g., Ferguson, 1990; Escobar, 1995; Crewe and Harrison,

1998; Lewis, 2019), as well as global feminist (e.g., Abu-Lughod, 1996; Mohanty, 2003), intersectional (e.g., Crenshaw, 1991; Jones, 2012), and indigenous approaches (e.g., Agrawal, 1995; Sillitoe, 1998; Hobart, 2002; Hoover, 2017; Montaya, 2016). Increasingly, relationships between politics, societies, and resources are questions of major import in anthropological inquiry and critique. Considering the impacts to environmental systems from capitalism and neoliberal approaches to resource use and ownership is likewise a key area of focus [see, e.g., Smith's discussion of nature as accumulation strategy (Smith, 2007) as well as (Smith, 1984)]. While it is beyond the scope of this article to characterize the entirety of these broader literatures, the extent to which WaSH topics draw from each of these categories and contribute back to these major waves of thought cannot be understated.

In addition, critiques within anthropology that question the validity of approaches that attempt to characterize static "cultural" or "behavioral" interventions that can be utilized worldwide (e.g., efforts that complicate our understanding of social categories, for example, women), or attention to race and class as important social identities that inform how people relate to infrastructures and marshal resources, are central to the undercurrent of WASH work in anthropology. The entire tradition of anthropology, and the broad-based training in critical social and cultural inquiry it provides, creates a base of knowledge for anthropological practitioners within WASH, which can be widely important; as such, it is not only the work within anthropology that specifically speaks to WASH but also the way in which anthropologists are taught to think, act, and research as a whole that informs this work.

It is important to note that in anthropological research, researchers' experiences are one of the most important data collection tools (Agar, 1996). For example, through participant observation (Spradley, 2016) and practice (Mullins, 2011), anthropologists utilize their own experiences, as well as their discussions and interactions with those around them, to form their theoretical perspectives and applied products. As such, anthropologists treat memory, experience, and analytics as data. While these data are often more inductive than deductive, they are vital to anthropological understanding. Thus, at times, the authorship team offers insights from their own first-hand experiences in the field. Also worthy of note is that, when working across disciplines, things that are common knowledge to anthropologists (e.g., the relevance of culture and the importance of attention to gender, class, and race) become less of a "given" in other fields. Although in the case of this article, the authorship team knows that these perspectives may be new for some readers, and thus we provide examples of case studies or literature where these concepts are applied, we also think it worthy of note that such concepts are common knowledge within basic anthropological training, and thus often as mechanical and habitual to an anthropologist's approach as quantitative problem solving would be to an engineer. This is one of the major reasons why collaborating with anthropologists, when possible, is recommended, rather than simply trying to apply these broad concepts without the input of a professional.

Water

Anthropological approaches to water are diverse and consider everything from the co-creation of water and culture to technical experiences of water and water management.

Cultural anthropologists are concerned with the meaning of water, beginning with the premise that water is culturally constructed. That is, the meaning ascribed to it is culturally and historically specific, and there may be multiple meanings ascribed to it at any given time. Indeed, water is a "total social fact," meaning it is both a biological requirement and a social reality (Orlove and Caton, 2010). Strang's work on the meaning of water is a deep dive into water's social, cultural, and experiential meaning beyond its material nature (Strang, 2004). We see, for example, specific kinds of water as medicine according to tribal members who recognize the spiritual nature of water (Wilson *et al.*, 2019). In addition to exploring the meanings of water, scholars hold that water as a material object cannot be divorced from the social context as water and culture are co-constructed, that is, water and society are so interrelated that the environment influences culture, which in turn influences the environment. As such, some work has delved into the ways in which water is perceived and valued beyond its use (Flotemersch *et al.*, 2019).

Similarly, water management is socially prescribed. Environmental, anthropological, and human geographical approaches, specifically those engaging political ecology, assert that processes of water availability and access are multiscalar (Gezon and Paulson, 2005), meaning that local experiences of scarcity are connected to larger social and economic systems. Political economic approaches similarly situate water insecurity within the larger political economic context that drives disparity (cf. Swyngedouw [2009], see discussion of political economy of health below). Scarcity, then, is not solely hydrologic, but is politically and socially created (Mehta, 2003, 2014). Indeed, according to Bakker (2012), water is both political and biopolitical; water is both sociotechnical and sconatural. In this vein, one does not have power over water, but rather power through water. In addition, political ecology approaches highlight the co-constructed (i.e., dialectic) relationship between people and their environment. Put another way, humans affect their environment and the environment affects them, and together, this circular feedback creates meaning and attachment for people to their environments, and makes environments at times reflective of the relative power and positions of those that have shaped it (see Swyngedouw, 2009; Robbins, 2011; Carse, 2012).

The notion of water as a cultural property and human right remains a key area of research, as highlighted by recent scholarship on integrated water resource management (Mehta *et al.*, 2017; Workman, 2019a) and indigenous rights (Yates *et al.*, 2017; Wilson, 2019). Policies aiming for equitable provisioning of water may inadvertently reproduce social divisions (Mehta *et al.*, 2016, 2017), and there are important macropolitics and micropolitics to understand (e.g., Workman, 2019a). Literature on the human right to water, how this right is conceptualized, and the realities of fulfilling this human right are likewise central to the understanding of water (Winkler, 2012). In some instances, these perspectives have been utilized to garner power against water privatization (e.g., in Cochabamba, see Assies [2003]; Mehta *et al.* [2014]), but right-based arguments related to water have likewise been co-opted and have actually served to further marginalize existing disadvantaged groups (e.g., in California's Imperial Valley, see Waller [1994]; Andrés and Evans [2014]). Discussions of water as a commons resource are likewise useful for conceptualizing water allocation, use, and conceptualization (Ostrom,

1999; Cairns, 2018b). Thus, the water cycle is hydrosocial, not just hydrological (Swyngedouw, 2009; Linton and Budds, 2014; Sultana and Loftus, 2015).

Relatedly, social scientists have refined our understanding of “water security.” The definition of water security accommodates several important dimensions, specifically, affordability, reliability, sufficiency, and safety (see Jepson *et al.* [2017] for current thinking on measuring water insecurity and Young *et al.* [2019] for the development of a validated water insecurity scale). Importantly, water insecurity is a lived experience, meaning that a reduction in one or more dimension(s) leads to biological, psychological and socio-environmental (i.e., biopsychosocial) effects (Rosinger and Young, 2020). Previous definitions of water insecurity have been extended beyond quantifying scarcity to account for the politics and relations of water provisioning, as iterated in a relational approach, for example, which holds that water security is not just about securing water as a material good, but rather focuses on the social relations of access (Jepson *et al.*, 2017). Indeed, there is notable psychoemotional and psychosocial stress associated with water insecurity, driven in large part by the experience of inequity (Ennis- McMillan, 2001; Wutich and Ragsdale, 2008; Stevenson *et al.*, 2012, 2016; Jepson, 2014; Workman and Ureksoy, 2017).

Resource insecurity is necessarily gendered, with women and men experiencing its effects differently based on socially prescribed roles surrounding water and water management (Ferguson, 2005; Harris, 2009; O'Reilly *et al.*, 2009; Sultana, 2009; Wutich, 2009). The gendered nature of water needs, and water security is recognized within international development and related fields. Gender has been mainstreamed in WASH programming for several decades. However, research on gender mainstreaming indicates uneven application, lack of efficacy, unexpected negative outcomes, and even forced participation of women in WASH sectors (Crow and Sultana, 2002; Harris, 2009; Cairns *et al.*, 2017; Fisher *et al.*, 2017).

Infrastructure studies provide a useful frame for addressing the intersections of water and WASH technologies, as well as the politics of WASH infrastructure. Infrastructures form connective elements of our societies (Edwards, 2002); they shape society and are shaped by society (Monstadt, 2009). They are a central, but often “invisible” component of water realities. Anthropologists have completed technopolitical/critical investigations into infrastructure plans for water provision, access, and costing (Eichelberger, 2010; Anand, 2017; Cairns, 2018b). Others have explored connections between nature and infrastructure (Carse, 2012). Anthropologists critique the systems of development that produce and reproduce water problems, and these scholars often promote a critical review of the schemas for both infrastructure development and water provision (Johnston *et al.*, 2012). The valuation of water is often tangled with infrastructural considerations; social scientists have addressed intricacies of when, how, and why water is used (Gleick, 2003), commodified (or not) (Bakker, 2007; Teodoro, 2018), and how this toggles with the costs and realities of infrastructural decision making (Von Schnitzler, 2013; Beresford, 2020). In South Africa, citizenship (one's position vis-a-vis the State) is created through a person's relationship with water and sanitation infrastructures, *inter alia* (Lemanski, 2019). These approaches provide a useful conceptual bridge into sanitation, as infrastructural regimes (e.g., flush toilets) often require the use of water for sanitation.

Sanitation

Sanitation is a multistep process in which wastes are managed from the point of generation to the point of use or ultimate disposal (Tilley *et al.*, 2008); this management separates human waste from human exposure and prevents contaminants within it from impacting human or environmental health (Mara *et al.*, 2010). WASH programs and sectors have historically glossed “sanitation” as either consisting solely of centralized wastewater treatment systems or the construction of toilets, septic systems, or latrines. This rather narrow perspective omits several components of the sanitation service chain, such as the collection and conveyance of fecal sludge and septage and the end use of treated effluent and biosolids (World Bank, 2004; Tilley *et al.*, 2008). Furthermore, it generally prioritizes providing these technologies and systems, and the community buy-in and payment for them, over other alternatives, and importantly over attention to the broader cultural or social systems that encompass and encourage these infrastructures (Tilley *et al.*, 2014). Moreover, “sanitation” (as used by policy makers and technologists) sometimes only considers adequate wastewater treatment infrastructure as requisite.

As outlined above, anthropologists and other social scientists have made considerable contributions to the topic of water. However, their contributions to research on sanitation have been more limited. The anthropology of toilets, pipes, sewage systems, pollution, wastewater treatment, and reuse is marked by a few key anthropologists and social scientists who have interrogated theoretical and applied topics related to these infrastructures. Notably, some central contributions to this work were borne of collaborative interdisciplinary programs (Tumwebaze *et al.*, 2011, 2014; Tumwebaze and Mosler, 2014; Verbyla *et al.*, 2015, 2016; Cairns *et al.*, 2017; Hyun *et al.*, 2019). Beyond this, the topic of shit itself, as well as broader studies of waste and the impact of wastewater pollution, and the adoptability of wastewater reuse stand out as key contributions from anthropology, alongside health-focused understandings of sanitation's impact, efficacy, and accessibility. Emerging work on sanitation insecurity in wider social science spaces is likewise central. Understanding the marginalizing impacts of sanitation (or lack thereof) is a recurring theme throughout all of these anthropological endeavors.

Anthropological work has addressed the ways in which infrastructural regimes, especially those favoring flush toilets and centralized sewage collection, often win out over lower-cost, indigenous, or community-led alternatives, and systems for both sanitation and wastewater treatment are designed and implemented—thus impacting marginalized communities worldwide (Verbyla *et al.*, 2015). Likewise, it has outlined difficulties with how sanitation systems are governed and priced within a community, shown these decisions as often related to choices about water provision, and outlined how these paradigms can complicate the efficacy and accessibility of WASH access (Cairns, 2018b). Anthropological currents in sanitation also discuss the ways in which public infrastructures for sanitation are experienced by local populations, and how they can both create opportunities for inclusion and redraw experiences of exclusion (Chalfin, 2014). Kelly Alley's ethnography, focused on wastewater pollution in the Ganges, notes several tensions related to individual expectations about sewage and wastewater

treatment facilities, as well as spiritual ecological components of relationships with polluted river water (Alley, 2002). Historical work on the evolution of public toilets from ancient (e.g., ancient roman toilet infrastructure, see Nash [2018] for a quick overview, Antoniou *et al.* [2016]) to more contemporary examples (e.g., London's 1890s sewer system designed by Balzaguette, see Halliday [2013]) shows how culture and class intersect with health and status of individuals and communities. Reaching back to Larkin's work on the politics and poetics of infrastructure is as important here as it is with water—sanitation can be found to have meaning as it is experienced aesthetically and materially (Larkin, 2013). As a result, there may be important disconnects between social expectations of technologies and ecological and economic expectations (del Carmen Morales *et al.*, 2014).

Drawing from seminal work in anthropological thought, understandings of cleanliness, hygiene, purity, and danger (cf. Douglas, 1966), and the anthropology of disgust (discussed further in the hygiene section of this article) have been paramount to the understanding of human waste itself, and have given way to an increasing attention to the realities of human shit (the word “shit,” here, is used purposively to highlight the phenomenology—or the human experience of—interaction with excrement, see Jewett [2011]). The inability to separate oneself from shit during the Anthropocene (Kawa, 2016) is a burgeoning area for theoretical exploration in anthropology, as is the productive afterlife of human waste (Jewett, 2011) and waste's reuse potential within the wider food-energy-water nexus (Verbyla *et al.*, 2016).

Anthropologists are interested in the realities of wastewater pollution and the ways in which pollution requires cultural perspectives on religion, cleanliness, and community cohesion to adjust themselves (or not) to practical realities. For example, the widespread transformation of Japanese society after World War II, from a squatting culture to a sitting culture, and to “hands-free,” automated toilets, was largely accomplished through advertising campaigns that considered the society's ethos for cleanliness (George, 2008). The work by Cairns *et al.* (2017) in the Western Balkans examined community-engaged approaches to addressing multiple waste streams, including human waste. Social scientists have studied smaller-scale infrastructure such as latrines, on topics related to user satisfaction, determinant factors with maintenance, technology uptake, and shared sanitation (Tumwebaze *et al.*, 2011; Tumwebaze and Mosler, 2014; Tumwebaze *et al.*, 2014).

Also, with the exception of research on the stigmatizing nature of manual emptying, for example, male pit-emptiers of Dar es Salaam, Tanzania, working overnight to avoid being identified (Jenkins *et al.*, 2015), the role of social “disgust” and the caste system in India in keeping “honeysuckers” invisible (Prasad and Ray, 2019), and Coffey and Spears' (2017) study, which found that because of Hindu notions of purity and caste, open defecation is preferable to manual pit emptying in India, few anthropologists have explored the cultural dimensions of onsite sanitation systems in terms of meaning and materiality. This is an important avenue for future research.

Like water, effective sanitation systems are dependent on larger social relations and social structures. However, many more people globally do not have access to adequate sanitation. Indeed, geographers describe “geographies of exclusion,” whereby provisions are spatially unequal (literally and

metaphorically). For example, Jewitt (2011) asserts that unequal access to sanitation has created geographies of shit where some people are literally and metaphorically closer to shit. There may be notable divergences and overlaps in processes of marginalization in the global North and South, and this is further complicated in distinguishing insecurity in rural versus urban areas (cf. Ranganathan and Balazs, 2015). Within the global North, effective sanitation has reduced the overall burden of enteric infections, although it has not eliminated it entirely. Insufficient sanitation is associated with poor health outcomes. As with water insecurity, geographers and social epidemiologists are working to operationalize sanitation and toilet insecurity (O'Reilly, 2016; Caruso *et al.*, 2017). From an anthropological perspective, the lived experience of such insecurity is important as research indicates it is associated with psychoemotional distress (Sahoo *et al.*, 2015).

Also, importantly, gendered identities influence perceptions of sanitation infrastructure, its importance, its use, and how it is experienced. In some societies, for example, men and women are not allowed to use the same toilet and, thus, households will have multiple latrines built. Gender similarly relates to whether or not someone would choose to use community latrines or may reject latrines altogether in favor of open defecation (Thys *et al.*, 2015). Women have reported feeling unsafe using latrines, and there are reports of sexual violence against women en route to using a facility or while seeking privacy for open defecation (Caruso *et al.*, 2015; Sommer *et al.*, 2015; Khanna and Das, 2016). Moreover, feeling safe while using a facility is important; thus, implementers must ensure sufficient privacy, lighting, and cleanliness (O'Reilly, 2016). The issue of menstruation, which often falls under the heading of “hygiene”, is a particular barrier to sanitation for individuals who menstruate (Hulland *et al.*, 2015; Caruso *et al.*, 2017). Menstruation overlaps with other feelings of shame and cultural prescriptions for women and girls, and often comprises an “invisible” barrier to accepting new practices. The lack of adequate WASH infrastructure for menstruation is a psychoemotional stressor (Hulland *et al.*, 2015). Indeed, a review of sanitation in the global South found that gender-sensitive sanitation must include local understandings of shame, dignity, and status and account for safety and privacy while toileting (Tilley *et al.*, 2013). In our experience, women are often blamed for clogging pipes or pits with pads or tampons, for instance, when solid waste (e.g., plastic bags, bottles, etc.) are often the culprits. Considering gendered, classed, or otherwise stratified components of sanitation and hygiene experience is paramount. De los Reyes and Workman are currently engaged in research into the gendered dynamics of sanitation-related decision making, specifically pit latrine management and emptying.

There are several urgent calls that highlight a key need for anthropological and social science contributions to this space. It is generally assumed that increasing access to improved sanitation will prevent diseases related to excreted pathogens (e.g., diarrheal diseases). However, mixed results have been reported in studies of this outcome following independent (sanitation only) and combined (WASH together) interventions (Clasen *et al.*, 2014; Pickering *et al.*, 2015; Luby *et al.*, 2018; Null *et al.*, 2018), possibly due to a variety of social and cultural factors that influence access or

confound the impact of sanitation interventions in other ways. For example, the flow of pathogens in excreta is intimately connected to flows of finance, access to labor, and political power, making it essential to approach the topic using a transdisciplinary approach (Hyun *et al.*, 2019). Cairns' current work is focused on the relationship between wastewater pollution, pathogens, and human health outcomes in coastal locations, and is collaborative with biologists (González-Fernández *et al.*, 2020).

Hygiene

Hygiene is a key aspect of WASH; however it is often difficult to implement and is entangled with culturally specific experiences. Many hygiene interventions and studies focus on hand washing and personal cleanliness, although the topic also includes menstrual hygiene, industrial hygiene, and food hygiene. Anthropological perspectives on this topic critique and question the construct of “cleanliness” and the way it is encouraged within WASH approaches. Historically, hygiene has been used to exclude, marginalize, and control—as an example, different groups have been categorized as carriers of disease (e.g., HIV, cholera). For instance, anti-Haitian stigma proliferated in the Dominican Republic, with Haitians blamed for spreading cholera (Keys *et al.*, 2019). While decades apart, this sentiment mirrors the blame of Haitians for the spread of HIV in the United States (Farmer, 1992).

Referred to as “hygienic citizenship,” Bashford (2004) interrogates the—arguably very white and Western—notion of individual responsibility for hygienic practices and protection from disease. In this instance, individual management of tuberculosis (TB) is idealized, negating social structures facilitating the spread of TB (Bashford, 2004). Biopower deals with the ways behavior is governed within WASH. Studies related to biopower are focused on how there is often a marginalizing effect to people who do not meet hygienic requirements, even when there are socioenvironmental obstacles preventing them from following these practices. Long-standing anthropological criticism of development has also centered on the implicit racism of colonialism (and neocolonialism), whereby black bodies and non-white people are viewed as diseased and unclean (cf. Comaroff, 1993).

Community-led total sanitation (CLTS) is an approach where sanitation technologies are promoted over open defecation by shaming open defecators through an approach known as “triggering” (Bardosh, 2015). Social scientists, however, have found that shame-based approaches to CLTS can exacerbate existing marginalization within communities when individuals are unable or unwilling to maintain project-driven levels of sanitation or hygiene (Brewis *et al.*, 2019). Again, the anthropology of disgust offers key insights into perspectives on hygiene (Bubandt, 1998). For example, individuals experiencing homelessness have extremely poor access to sanitation and hygiene (Moffa *et al.*, 2019; Flanigan and Welsh, 2020) and are implicitly stigmatized by health care workers, social service providers, and other members of society (Brewis *et al.*, 2019; Budescu *et al.*, 2021), which may motivate perceptions that lead to disgust and contribute to not in my backyard attitudes and further denial of their access to public WASH facilities (Clifford and Piston, 2017).

Differential experiences of cleanliness, the best ways to achieve cleanliness, and the actions needed to address these

issues are key for anthropologists and WASH teams to understand. This is because hygiene is biopolitical and potentially harmful if implemented incorrectly, but it is also often relevant, wanted, and necessary. It will be key to use an applied approach that balances critiques of colonial and imperial approaches to global public health, recognizes that (neo)colonialism drives inequity in sanitation and may result in indignity, and acknowledges the need for hygiene programs. While biomedical understandings of disease origins and vectors may conflict with indigenous understandings, the practice of working with local understandings has proven more effective than trying to enforce different perspectives (top-down approaches for “behavior change”). It is thus important for anthropologists to work with epidemiologists and program implementers in infectious disease prevention. Anthropologists can bridge indigenous cultural models with biomedical approaches (see Hewett and Hewett [2007] for anthropological contributions during Ebola epidemics).

A Note on WASH Marginalization in Higher Income Countries

WASH security in the global North may look different than in the global South. Most research on WASH inequities in the global North can be found in geography and environmental justice literature (Jepson and Vandewalle, 2016; Deitz and Meehan, 2019; Meehan *et al.*, 2020). However, anthropologists are increasingly addressing processes of marginalization in the global North (Wutich *et al.*, 2012; Zarger *et al.*, 2019; Radonic *et al.*, 2020). As in the global South, there are political and economic processes driving exclusion and resultant racial/ethnic and class disparities caused by long histories of systemic racism and oppression (Heaney *et al.*, 2013; Jepson and Lee Brown, 2014; Jepson and Vandewalle, 2016; Stillo and Gibson, 2017; Leker and Gibson, 2018; Rosinger *et al.*, 2018).

Scholars have recently corrected several “myths” about water insecurity in the global North (Meehan *et al.*, 2020), specifically the myth that the global North does not have water or sanitation inequities. In the United States, there are multiple examples of WASH inequities, often arguably driven by institutional racism (e.g., Pauli, 2020; 2019). Research also indicates that there is tension between First Nations and governmental organizations regarding water management (Eichelberger, 2010; Simms *et al.*, 2016).

Anthropologically speaking, trust in water policy and infrastructure is important and what constitutes water quality and water safety should be explored ethnographically and critically (Gartin *et al.* [2010]; Wilson [2014], see Pettit-Riley *et al.* [2010], Workman [2019b] for examples in the global South, Cairns [2018a] for a comparative of global South and U.S. perceptions of trust in infrastructure). On the sanitation side, there are examples that show similar issues, including the “Alabama crisis,” which highlighted rural Alabama’s struggle with tropical disease resulting from inadequate infrastructure for sewage (Winkler and Flowers, 2017).

Health Disparities: Theorizing Difference in WASH Health Impacts

Anthropologists, geographers, and social epidemiologists have demonstrated social determinants of health and health disparities; that is, poverty, exclusion, *inter alia*, all drive

health outcomes. Anthropologists assert that health, then, is biocultural (Leatherman and Jernigan, 2015). Known by several terms, including critical medical anthropology and the political economy of health, proponents of these frameworks note the social patterning to disease incidence and prevalence. That is, some communities have been marginalized by social relations, including racism and classism. In terms of WASH, the inequitable distribution of water and sanitation has profound health effects. Within anthropology, the medical anthropology of water (Whiteford and Vindrola Padros, 2011) outlines the myriad health effects from water insecurity, effects that are biological (Whiteford and Vindrola Padros, 2011) and psychoemotional (see previous section). As discussed above, results from recent clinical trials indicate uneven results from WASH and nutrition interventions, indicating that current understandings of WASH may be missing important exposure pathways that contribute to the overall disease burden related to WASH. Scholars have suggested that the “A” in WASH should be amended to include animals (Prendergast *et al.*, 2019) and/or air quality (Clasen and Smith, 2019). Indeed, there are important connections between water and food security (Brewis *et al.*, 2020; Workman *et al.*, 2021). The One Health approach (Gibbs, 2014) recognizes the importance of both human and animal health, critical given the co-occurrence of food insecurity, water insecurity, and infectious disease, particularly zoonoses. Multispecies ethnography (Kirksey and Helmreich, 2010) recognizes that humans and animals biologically shape one another and offers one method to explore this broader understanding of WASH.

Endeavoring to Create a More Equitable WASH Environment

In an effort to highlight the ways in which interdisciplinary teams of scientists can harness anthropological and social sci-

ence insights throughout their work, we identify six “C’s” for WASH perspectives that are inclusive and designed with attention to wider sociocultural needs (Fig. 1). These C’s are a critical meta-analysis of major issues that span water, sanitation, and health categories—put another way, they transcend and connect the W-A-S-and H in “WASH.” These C’s also highlight key insights from anthropology, as well as key tensions/barriers to integrating sociocultural information and actioning programs that take these perspectives into account. These C’s are an amalgam of insights from major themes in the field (as introduced within the earlier literature review), as well as major issues that the authors have found mirrored within their work and thus theorize as centrally important to the practice of engineering going forward. As such, and as is reflective of the critical review approach, the C’s are essentially a synthesized discussion of theoretical insights from the literature and, in response, an overview of the authors’ suggestions for innovation within this field. The authors developed the C’s to offer representations of knowledge that anthropologist-engineer teams garner from their respective fields as well as experience, but rarely find an academic space to discuss at length. Suggestions are given for actions that engineers and others can take to ensure equitable programs and synergistic teams.

Critical

Critiques of WASH systems are often dismissed as being intellectual without being actionable. There is often a concern, when there are new programs and ideas being launched in engineering circles, that the onslaught of criticism from anthropologists and the like will stymie progress and development. We believe that the opposite is true: critique, when included from the onset of programs, leads to improved efficacy and long-term sustainability. Unfortunately, many approaches in engineering and other fields purport to consider

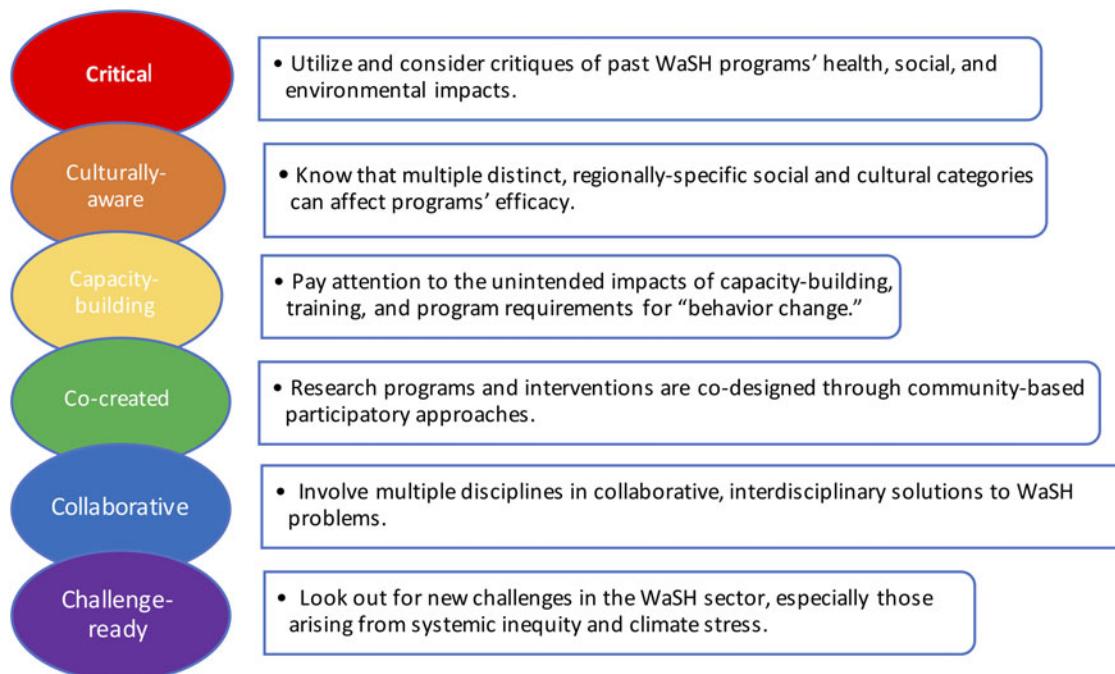


FIG. 1. Focus on six “C’s” to create a more equitable WASH sector. WASH, water, sanitation, and hygiene.

social and contextual issues in a community (see Mehta *et al.* [2016] for a discussion of, for example, Integrated Water Resource Management in a special issue dedicated to the topic), but in practice, these approaches only allow for a shallow representation of the “social,” with cultural information often garnered from simple surveys or other inadequate assessments. The theoretical approaches in anthropology allow for a more critical enactment of equity politics, on-the-ground intersections between class, gender, and other categories, and subtle micropolitics (e.g., Chalfin, 2014; Cairns *et al.*, 2017; Workman, 2019a). It is true that anthropological research takes time—and is “costly” for that reason (although rapid rural appraisal and other anthropological techniques can allow for faster data if done well, see Sangaramoorthy and Kroeger [2020] for rapid ethnographic approaches). However, as with so many things in anthropology, the experience of the researcher is an important factor in data collection, and as such, “fast” anthropological research can only be done by anthropologists with significant experience, expertise, and evidence. Relatedly, monitoring and evaluation programs often provide numerical “check boxes” related to piped connections, toilets, etc., but miss the importance of the “how” for the ways in which individuals actually experience these components of WASH projects and the efficacy of uptake, and other issues (Cairns, 2018b; Workman, 2019b). Critique and feedback are necessary throughout an entire project to ensure success. Anthropologists and community stakeholders should be engaged from the outset—not just at the end of projects—to ensure cultural appropriateness or “fit” of a technology. Local anthropologists, or anthropologists who have done years of research within the country or region where projects occur, are often a best bet—but anthropologists who focus on topical concentration can often study that topic in many locations. Working with applied anthropologists, who specialize in applied research and solve urgent current problems, is often a good choice when implementing systems. We acknowledge that many anthropological works and journal articles are inaccessible, because of cost to access academic publications as well as because of the discipline’s penchant for problematizing and the use of jargon. Anthropologists need to learn to speak across disciplines. Despite this tendency, anthropologists often have keen insights into these topics. There needs to be focus on what we are measuring, why we are measuring it, and what a truly inclusive WASH paradigm means both theoretically and practically. Anthropological inquiry is not the same as simply qualitative research—it is the iterative (i.e., emergent, learn-and-adapt), praxis-based (see Kozaitis, 2000) approach that makes it particularly valuable.

Culturally aware

Cultural models refer to belief schemas that organize domains of thought, for example, how water and sanitation security or appropriate technology are understood as culturally specific. Water insecurity may be driven by hydrogeological, meteorological, or social factors, or a combination of all three, but, more than not, social factors are chief among these drivers (Linton and Budds, 2014). Moreover, what constitutes security is similarly culturally specific, for example, water is understood as a resource, as a human right, as an integral part of the cultural

landscape (see discussions in Goodale [2009]; Cairns [2018b]), that is, water as medicine (Wilson, 2019). Social theorists posit that technology stems from culture, but also changes it, for example, the implementation and use of handpumps in Mozambique was influenced by culture and, in turn, shaped social relations, specifically gender (Van Houweling, 2015). Indeed, we cannot assume technology is universally experienced. Rather, the way technology is incorporated depends on previous cultural experiences related to technology, the availability of trained operators, and the capacity of that community to exhibit resilience in the face of technological interruptions and malfunctions.

Social relations are culturally specific, and beyond that, even within cultures, there are additional identities that influence human interactions with technology, for example, class (Mehta *et al.*, 2017). How water resource management is perceived is based on socially prescribed roles about resource management, but exists within other social relationships and understandings of appropriate behavior and responsibility (e.g., Workman, 2019a). Implementations are necessarily culturally adapted; individuals and communities may embrace a new technology or development agenda, but there are several important caveats. Even when there is sufficient water, not everyone has equal access (e.g., Shah and Narain, 2019)—same is true for sanitation (Jewitt, 2011).

Anthropological critiques of development are important because lessons learned in international work can be applied globally and domestically. Balancing a global perspective to understand the scope of insecurity or WASH needs with local perspectives that iterate based on lived experience is paramount. Development initiatives must align with existing cultural models or be able to bridge the gap. However, social scientists stress that it is insufficient to assume that a culture will adapt or that we overcome “cultural barriers.” Instead, technologies or interventions must make sense from the perspective of the communities receiving it. The terms “traditional culture” or “cultural barriers” assume that the people with whom we work are culturally lacking (read: not modern) and that their existing belief systems are problematic and must shift to accommodate development. For example, behavior change initiatives often rely on discourse about changing “traditional gender roles,” which assume a universal subjugation of women and often portray men as domineering or disinterested in family life. This emphasis on women’s empowerment relies on the belief that empowerment, generally financial, is beneficial to all women (Chant and Sweetman, 2012), and this perspective has been critiqued as rooted in white feminism and has racialized overtones about non-white men as actors (Cornwall, 2000). These multiple different perspectives show the very point that we are making: cultural experiences are myriad and context specific and considering the power relationships embedded within culture alongside spheres of influence on socio-technical system adoption is necessary.

Capacity building

A focus on “behavior change” and “capacity building” in WASH programs can sometimes lead to an inability to claim responsibility for the impact of inappropriate technology. Changing behaviors and adapting capacities can sometimes be necessary, but reliance on those changes can detract from

predevelopment work that needs to be done to ensure relevance and “fit” within a cultural context. Moreover, while building workforce capacity can be beneficial, for example, training water system operators, the impact of such capacity building can sometimes re-entrench existing inequalities (e.g., gender, etc.), and can also lead to “brain drain,” wherein well-trained individuals leave the public sector and/or leave the region entirely for better-paying jobs (Doquier and Rapoport, 2012).

This is not to say that the goal of educating individuals on topics related to WASH or providing training is invalid; it is simply to say that relying completely on change to make the project work is not reasonable. Programs that rely on or dictate behavior change are often problematic and ineffective. For example, CLTS approaches to achieve Open Defecation Free communities represent a strategy wherein organizations might only offer latrine technology if people commit to behavior change. Indeed, they can also reinforce shame related to defecation practices, realities, and structures within societies previously reliant on open defecation (e.g., Brewis *et al.*, 2019). Requiring these programs is not effective, and potentially harmful. However, there is some benefit to encouraging capacity building and health promotion. There have been marked gains in these areas within certain communities, however uneven the uptake (Ramesh *et al.*, 2015). One thing that agencies can do to better demonstrate positive gains is to more effectively monitor and evaluate positive outcomes, and how they were realized. Sometimes programs do not work because of pre-existing relationships with development, and may have nothing to do with either the technology or the program. If communities distrust an organization, they may also distrust technologies promoted by that organization (Cairns *et al.*, 2017). In all aspects, however, the “human” requires more attention than it is currently getting in the realm of what changes are asked, and how they are affected.

Co-conceptualized/co-created

Participatory processes involve the conceptualization of an intervention or technology through a meaningful interchange between community, government, scientists, and other stakeholders (see Schneider and Rist [2014] for a discussion on transdisciplinarity and participation). Co-conceptualization refers to the process of design, where the relevance, need, and appropriateness of a project is ground-truthed with the community, while it is checked for social and scientific viability. Such approaches represent significant time and cost investments, which are often difficult to obtain for development organizations and applied scientists. However, exploratory research (e.g., *ex ante* analysis) before implementation of an engineering project is important and should involve social scientists. The importance of project acceptance and the long-term benefits of “buy-in” are often underestimated. Within anthropology, design anthropology is gaining salience (Gunn *et al.*, 2013). Anthropologists in this subdiscipline work with communities and individuals to co-design technology or infrastructure. Rapid (less time-intensive) participatory approaches have been critiqued as being divorced from their original activist roots and can easily devolve into buzzwords and funding requirement lingo (Cooke and Kothari, 2001; Williams, 2004). However, participation can be key to including communities and stakeholders in wider WASH policies and pollution abatement programs (Cairns *et al.*, 2017).

In summary, true community participation in WASH projects can be difficult and costly, and may be fraught. Recognizing existing collective trauma from colonialism, racism, and, for example, recently, the effects of the COVID-19 pandemic, among others, can help WASH initiatives be more successful in the long term. WASH is only one feature of the totality of human experience. Thus, an emphasis should be placed on collaboration, shared expectations, and the recognition of power imbalances and systemic processes that drove marginalization in the first place.

In a similar vein, anthropological research can be beneficial when creating and/or conceptualizing new technologies and technological impacts. For instance, questions such as whether or not to use centralized or decentralized technology for WASH (e.g., Verbyla *et al.*, 2015), as well as questions of usage programs, can be influenced by myriad factors that extend far beyond spatial or hydrological concerns. There are both immediate and long-term constraints to technological acceptance that may stem from historical, experiential, and political experiences. Key actors and players, as well, can have a major impact on a project’s success, and understanding these different programs and actors is well within the wheelhouse of social science disciplines. A good example of the need for this is the success of “condominial sewers” or simplified sewers, the development of which was contingent on the engagement of key influential community leaders (Nance, 2013). Thinking outside of “business as usual” when implementing programs is very important to overall success.

Engineers who are interested in sparking up collaborative efforts with anthropologists or other social scientists to achieve co-conceptualized and co-created research or design should seek individuals who have experience with applied research. Engineers should also anticipate negotiations regarding the length of time required to develop a truly co-conceptualized or co-created intervention/design, and should challenge their social science colleagues to describe their approaches in terms of a long-term investment (i.e. evaluating the costs and benefits of achieving equitable outcomes, project acceptance, and “buy-in”).

Collaborative

Collaboration between and among WASH scientists of different disciplines is paramount; and to do this well, scientists must learn to work in interdisciplinary and—ideally—transdisciplinary spaces. The first and most important component of interdisciplinary effectiveness may very well be everyone involved’s willingness to seem like a total idiot sometimes. Interdisciplinary work requires humility, and a willingness to learn and grow. Assuming that a passing familiarity with another discipline’s approaches or method equates to extensive training is problematic. Interdisciplinary collaboration by its very nature requires deep disciplinary knowledge. Put another way, recognize when those you work with have expertise that you do not, and vice versa. Theoretical training in anthropology is integral and rigorous; theoretical approaches studied over several years are vital to the way that anthropologists employ method; knowledge of method in itself is not enough to practice a discipline. That being said, often, the perspectives of each person in an interdisciplinary group are best utilized to push the boundaries of the disciplines involved. Collaboration can be facilitated

by efforts such as team science (Stokels *et al.*, 2008). Learning one another's vocabulary is important as disciplines will have similar concepts using different terms. Anthropologists may conceptualize ideas differently than engineers; the start points are often different, and it can easily feel like anthropologists ask engineers to go backwards and start over from scratch, and like engineers ask anthropologists to "clean up" when programs go wrong (read: work on "engagement" or participation in postproject monitoring and evaluation). Both anthropologist authors have found that having a team of engineers they have worked with for years has facilitated deep understanding, respect, and friendship that is integral to successful projects.

In addition, subdisciplinary differences within fields are often difficult to see from the outside; there are different fields of expertise within disciplines, but we can differentiate environmental and medical anthropology in the same way as mechanical and environmental engineering and recognize that there is commonly subdisciplinary overlap. Development initiatives have been ongoing in the global South since the middle of the last century. While the belief is that knowledge and technology transfers from the global North to the global South, anthropologists and many development experts recognize the importance of indigenous knowledge. This thinking has been embraced by some engineers, who call, for example, for ethnoengineering—an approach to engineering that foregrounds local knowledge (Hess and Strobel, 2013). In addition, lessons learned from decades of research and development in the global South can be applied to the global North. For example, anthropologists, geographers, and other social scientists assert that research in low- and middle-income countries can guide our understanding of water insecurity in higher income countries (Meehan *et al.*, 2020).

Many funding agencies and major academic societies are focusing on the importance of convergence research—research that promotes diverse interdisciplinary strategies and innovative scientific research to tackle major world problems and promote discovery. The U.S. National Science Foundation identified convergence as one of the "10 big ideas for future NSF investments" (https://www.nsf.gov/news/special_reports/big_ideas/index.jsp) and the NAE (<https://www.nae.edu/113283.aspx>) outlined convergence as integral to solving major problems. This is certainly a central wave of thought that interdisciplinary scientists can utilize to fund, restructure, and rethink "business as usual" when it comes to WASH.

Challenge ready

Challenges in the WASH sector will continue to arise as globalization, diffusion of cultural knowledge and experiences, and increasing climate stress affect WASH programs. Achieving success in WASH programs is a very complex task, and what is clear is that narrow approaches to this concept do not work. Even with WASH infrastructure implemented *in situ*, the desired health outcomes may not be fully realized—and it might not be for the reasons suspected at first glance. Certainly, technologies themselves are implicated here—the technologies chosen can sometimes work in perfect conditions; real-world applications of some technologies may be difficult for monetary, social, or other reasons. At times, less is more. While lower-tech solutions do often work effectively, one needs to consider the ethics of these

options vis-a-vis their efficacy—put another way, we need to think through the ethics of "who-gets-what-where" in terms of technology. At times, no existing option will work, and a novel technology may be needed, or an underutilized or "niche" technology might need to be adapted. Also, however, WASH programs too often ignore other key factors of health and well-being, such as educational attainment, housing security, and social organization (Johnston *et al.*, 2012). Without integrated uptake of these technologies in light of myriad resource insecurity, failures arise.

That being said, there are some key problems with effectively implementing a truly integrated project. Time frame is one; there is often a push toward making programs quickly implemented—however, this approach leaves little attention to long-term impact. In addition, with an increase in neoliberal solutions to problems that may well have been once state responsibilities, all centered on "empowerment" can actually leave communities at the losing end of a devolution of responsibility (Hart, 2004; Harris, 2009). Moreover, as neoliberal approaches push local entrepreneurial responses to infrastructural needs—the responsibility may be contested (cf., Workman, 2019a). Public sector and entrepreneurial approaches are less regulated and can often lead to benefit and risk that is realized along class, racial, and other categories of difference.

The inclusion of "culture" into engineering and WASH approaches can, to social scientists, often feel superficial and ineffective. Programs that nod toward the cultural without truly understanding the historical and social realities of *place*, that is, peoples' connection to a region, can actually do more harm than good.

Moreover, the meaning of *things* may not be the same as envisioned by implementers. Indeed, we need to explore local understanding of what WASH entails as it may include solid waste and provisioning normally excluded from narrow WASH definitions. Anthropologists well recognize the impermanence of symbols; infrastructure and technologies are adapted locally and hybridized with local understandings. To add to that, important concepts and subtleties can get "lost in translation" in WASH programs where practitioners and community members are not fluent in the same languages; indeed, programs often assume an *a priori* and Western understanding of WASH and the related terminology.

The recent shifts within anthropology and other disciplines in social science from area to topical concentrations allow for synthesis of several related features in addressing the socio-environmental systems that relate to WASH focus areas. This work represents a body of knowledge to fill in what is often a "black box" in WASH initiatives and models, broadly referred to as "the human" or "the cultural." Defining water experiences beyond the presence or absence of water requires looking at interrelated aspects of WASH insecurity, myriad cultural factors, patterns of resource use, and perception.

Conclusions and Considerations for Future Research

Putting cultural information first, rather than using it as an explanatory feature for issues/risks within a project, is central. Before developing programs or research related to WASH systems, collaboration across disciplinary boundaries and with communities is paramount. This encourages attention to marginalization and extant power dynamics within a location where technology and engineering solutions will be

realized and ensures that the program is feasible socially, relevant to local publics, and inclusive of potentially marginalized groups.

Emphasizing strength assessments in conjunction with needs assessments will serve to be more inclusive and empowering. Monitoring and evaluation schemas must likewise be updated to reflect more humanistic aspects of infrastructure provisioning. Engineering for marginalized communities must focus on measuring the holistic drivers and impacts of a program, rather than simply implementing a series of *post hoc* check-box M&E schemas. As an example, utilizing anthropological theory allows us to see water insecurity is not just physical scarcity related to a lack of resources; it is driven by entitlements and power relations. Similarly, political ecology is a useful framework because it is multiscalar, linking policy, including governmental and transnational policy, to water outcomes. Utilizing partnerships with social scientists, for whom embedded, holistic international research has a longer history and as a result, more developed understandings of local realities, can be useful writ broadly.

Engineers, by the nature of their discipline, are tasked with the creation of technology and infrastructure that best addresses a given problem. Anthropologists, in contrast, begin by working with a community and from there determine how the community defines the problem and together articulate what they need. That is not to say that these approaches are incommensurate, rather, they represent differences in epistemology, that is, how do we know what we know and how do we reach a solution? Often, when anthropologists and engineers work together, it may seem that they are working in opposite directions, that is, starting with fully realized technology and then working with communities to implement versus starting with communities and then finding the right technology. It may seem as though these approaches cannot be aligned. However, we assert that anthropologists and engineers can work together although the realization that existing technology or recently developed technologies may be appropriate and can be adapted or by realizing that new technology must be developed through co-design. Before the implementation of any new technology, however, we hold that the communities, the scientists, and important stakeholders discuss their needs and expectations. Only then can decisions about adoption, adaptation, or invention be made.

Scholars must begin to extend the edges of the WASH paradigm's structure, asking important questions about how we might imagine different WASH futures, consider emerging concerns and contaminants, and harness new technologies and measurement abilities to address problems. WASH impacts and related comorbidities, then, must be considered a key factor in the totality of exposures that individuals experience over a lifetime, part of a web of larger interrelated structures that lead to human health risk. Likewise, WASH as a sector will be a major influence on the realities of humanity's environmental future. Considering how individuals, communities, and regions may experience marginalization throughout the process of WASH will prove integral to the outcomes, as will attention to the power structures within the academy. As we learn to redraw both the WASH development landscape and our disciplines themselves to forward more interdisciplinary, inclusive, and innovative approaches, the ethics of attention to the many ways in which WASH can marginalize—and on the flip side—include, will be paramount.

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