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Water Services for All? Placing Equity at the Center of Development Agendas in Water

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WATER SERVICES FOR ALL? PLACING EQUITY AT THE CENTER OF DEVELOPMENT AGENDAS IN WATER

ABSTRACT

In an attempt to achieve Sustainable Development Goals (SDG) for water, there has been a push to advocate for on-site modular or small-grid technologies as a supplement or substitute for conventional centralized water infrastructure. While a majority of work has been done in technology development, we seek to shift the conversation towards the role of equity when achieving SDGs. Here we emphasize the need for integrating equity in the adoption of new water infrastructure. This paper provides an expanded framework for defining equity in alignment with sustainable development, allowing other water infrastructure stakeholders to operationalize equity in their work. Although equity is applicable across the water sector, we focus in on an emerging field in the US where new types of technology systems are disrupting the conventional provision of basic services, specifically the case of onsite non-potable water systems in California. Enabling this study are semi-structured interviews conducted with stakeholders involved with on-site non-potable water reuse in San Francisco and the surrounding Bay area and qualitative analyses using a deductive thematic coding approach. Initial results confirm a general sentiment— equity is necessary, yet it is unclear how to incorporate this concept practice. In some instances, equity is viewed as secondary to utility planning, operation, and management; we propose that it should be incorporated intentionally as an approach to enhance service provision. This study has implications for literature and practice as it provides a more comprehensive definition for the various components within the equity discussion by categorizing forms of equity within economic, environmental, and social impact. Further, practitioners may use this work as foundational understanding in assessing internal operations and practices, improving infrastructure in the pathway to sustainable development.

KEYWORDS: water, equity, on-site non-potable reuse, sustainable development, decentralized

INTRODUCTION

Sustainability is defined as systems and processes that are able to function over long periods of time (Robertson 2014). This definition is often discussed with regards to three guiding principles: economic, environmental, and social sustainability. Sustainable Development Goal 6 (SDG 6) sets specific targets to '*ensure the availability and sustainable management of water and sanitation for all*' by the year 2030 (UN 2020). SDG 6 incorporates language referring to the need for '*equitable access*' and '*equitable sanitation*,' indicating that equity is fundamental to sustainability. While equity is used to operationalize sustainable development, it lacks a clear definition within the scope of water. For example, centralized systems seek to deliver water at equal quality and quantity across all end-users, and correspondingly many utilities assume this effort wholly satisfies equity needs across the system (Osman and Faust n.d.). In reality, centralized systems often deliver spatially unequal service levels, or provide water and services at prices that are unaffordable and therefore inaccessible (Faust, Abraham, and McElmurry 2016). In the US, not all communities are physically able to connect to centralized systems and this discrepancy tends to affect communities of color and indigenous communities disproportionately (Bate 2019; Guerra, Faust, and Charnitski 2019). Attempts to address these challenges are based in providing basic services and attaining equitable access; both the technology systems as well as the planning processes need to distinctly integrate equity into programming. A lack thereof leaves

the possibility for the current status quo to be applied to new technological systems, thus leading to further inequitable services (e.g., inaccessibility, unaffordability).

Alternative water systems is one approach being explored and piloted for city-scale adoption; for example non-grid and hybrid systems (e.g. source separation, on-site non-potable reuse, and others; Larsen et al. 2016). However, the adoption of alternative water systems requires the acknowledgement that the development of new technology also requires the development of supportive institutional environments (Hering et al. 2013; Larsen et al. 2016; Hoffmann et al. 2020; Hacker and Binz, n.d.). When alternative water systems are introduced at various scales (i.e. decentralized), the equity of distribution and accessibility to supply is brought into question. The shift away from a single method of service across a municipality leaves some end users with access to more resiliency in the face of external factors (e.g. drought, climate change). For instance, wealthier customers may be able to afford the redundant water systems, whereas lower-income populations may not. However, these alternative water systems help supplement centralized water networks for municipalities and end users by reducing the demand for potable water sources by reusing stormwater and wastewater onsite. As the water sector looks to supplement conventional technology configurations with sustainable alternatives, equity needs to be incorporated into these systems.

As the centralized network is diversified into decentralized technologies, the implicit assumption that end users have access to the same quality and quantity of service provision is brought into question. Additionally, the ownership of these decentralized technologies raises an equity issue such as the affordability and access to alternative water systems. Therefore, this study focuses on the broader equity implications for water infrastructure through a case study of on-site non-potable water systems (ONWS) in San Francisco, United States.

Previous work have explored equity in water infrastructure systems, defining it as '*the provision of a consistent minimum quality and quantity of water service to all end-users, determined at the local level'* (Osman and Faust n.d.). Other literature centers equity explicitly around economic impacts of affordability and pricing structures for utilities (Clumpner 2019; Nauges and Whittington 2017; Teodoro 2005). While affordability is explicitly connected to equity in water, there remains the possibility that other aspects of equity are implicitly present as well and require more intentional adoption in planning processes. For example, understanding who are the gatekeepers in infrastructure planning and are these individuals representative of the communities being served and which communities have access to diverse infrastructure options. This study uses the three pillars of sustainable development—i.e., economic, environmental, and social—as a basis for expanding the definition of equity (figure 1). Economic equity has already been discussed as the benefits and costs associated with systems, in alignment with the discussion of affordability in other work (McGranahan 2015; Clumpner 2019). Environmental equity refers to the quality and quantity of distribution and how this affects the resiliency of a system in the event of external impacts like climate change or natural hazards (EPA 1992). Finally, social equity encompasses the fairness of the system in its decision-making and access to services (Liu 2018). In the same way economic, environmental, and social impacts are assessed for sustainable development, this study uses these three same principles to demonstrate how equity is already present in water infrastructure planning, specifically ONWS. By identifying where equity is discussed, utilities can more effectively formalize equitable practice in programming and operations.

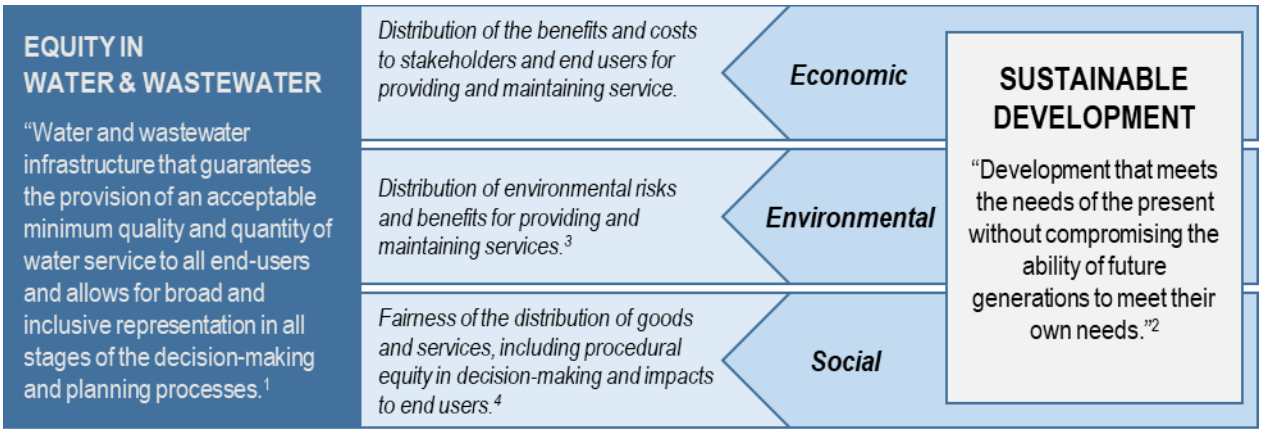

Figure 1. *Definition of equity in water contrasted with the triple-bottom line approach to sustainable development. Sources: [1](Hacker and Binz, n.d.); [2](WCED 1987); [3](EPA 1992)); [4](Liu 2018).*

METHODS

Currently, potable water is used for non-potable purposes within residential and commercial applications (e.g. toilet flushing, landscaping). One way to create more sustainable water use at the building scale is to supplement these non-potable uses with recycled water. Due to topographic constraints, it does not always makes sense to recycle stormwater and wastewater at a municipal level; ONWS provide another alternative to water recycling. ONWS have been piloted numerous times at a building scale (Hills et al. 2001; Šteflová et al. 2018; Alejandro Iribarnegaray et al. 2018; Alsulaili et al. 2017); however, few localities have adopted such technology systems at a city-wide level (Binz and Truffer 2016; Zhang et al. 2009; Binz and Truffer 2017; Rupiper and Loge 2019; Lackey et al. 2020). San Francisco, United States is one of the few cities around the world to have recently adopted a program (SFPUC 2018) requiring the implementation of on-site non-potable reuse and as such, was selected as the focus for this case study. As of 2015, all new developments over 250,000 sf within the SF limits are required to implement some form of greywater or wastewater reuse on-site (SFPUC 2018). Surrounding cities within the Bay area have also been met with developers from large corporations (e.g. tech companies) that are interested in following SF's example, expanding the need for cohesive regulations and governance structures. Such policy was implemented in 2018 with the passing of Senate Bill 966 which adopts risk-based regulation for ONWS at a state level (Weiner 2018).

In January and February 2020, 25 semi-structured interviews were conducted with stakeholders involved with on-site non-potable water reuse in SF and the surrounding Bay area (see table 1). Participants were initially contacted based on participation in local workshops for ONWS. Interviews were 30-60 minutes long, participants had a range of three to 25+ years of experience in public policy or engineering. Responses were audio-recorded with permission and transcribed. Questions focused on the participant's experience with ONWS, asking about how they became involved with the novel technology, their perception of the legal and regulatory framework, market development, and challenges that have been encountered along the way. Towards the end of the interview, participants were broadly asked about what role equity played in the adoption of decentralized water and wastewater technology. Due to the lack of a widely adopted definition in literature, participants were first asked how they would define *equity* and its application in the context of ONWS. Before concluding the interview, additional potential participants were identified through a snowball method (Crouse and Lowe 2018) and these individuals were contacted separately.

***Table 1**. Overview of stakeholder types included in interviews.*

Stakeholder Type	***Interviews***	***Role***
Building Owner	3	Program Manager, Project Executive, CEO
Design + Engineering Firm	2	CEO, Principal Engineer, Engineer
Sustainability Consultant	1	Founder
Environmental Organization	3	Director, Policy Associate, Program Associate
Government Agency (Local/State/Federal)	2	Program Manager, Assistant Director
Operator	4	Environmental Specialist, CEO, VP, Founder
Regulator	4	Consultant, Program Manager, Inspector, Engineer, Unit Chief
Technology Supplier	2	CEO, Project Manager
Utility	4	Head of department, Program Analyst, Program Manager, Planner
Total	***25***	

The interviews were qualitatively analyzed using a deductive thematic coding scheme based on definitions for economic, environmental, and social equity in figure 1. Excerpts are coded for content that implicitly related to equity, or is explicitly mentioned when asked about equity during the interview. Emergent themes are provided in the next section, along with examples described with the type of stakeholder that made the comment and the type of reference to equity (i.e. explicit or implicit) (table 2). The collated findings provide context for how equity is defined within the scope of decentralized alternative water sources, and the way in which such systems affect or are impacted by equity considerations. In identifying these examples of implicit and explicit reference to equity, connections can be made for how stakeholders can more distinctly provide equitable services through alternative water systems.

RESULTS

Of the coded interviews, 165 unique excerpts directly or indirectly discussing equity were found. Table 2 shows the three major components of equity (figure 1) that were coded using the deductive coding process, with their subsequent emergent secondary codes. The emergent codes show how stakeholders are conceptualizing equity in their work. Not captured in table 2 is the frequent initial response stakeholders had stating that equity is often not understood in their decision-making and overall systems processes. For example, one stakeholder when asked responded '*it's tricky. That's a question with an answer that can be turned around*' suggesting equity is complex and can be controversial. Another interviewee stated '*[to me] equity means, I as a building owner get something out of it, and I as a building owner put something into it*' further suggesting that equity is not clearly understood by some stakeholders. It is noted that 80 percent of the participants expressed a keen interest in learning more about equity with respect to their work and expressed some form of affirmation for the need to incorporate equity into infrastructure planning.

Equity is sometimes seen as a reactive response to infrastructure in light of controversy; for example, lead-contaminated pipes in NE American school water systems (Barchenger and Bureau 2020). However, equity can also be used as a proactive approach to facilitating legitimacy in utilities and technology systems. For example, one respondent (see Public Engagement, table 2) described that, "*once they understood what was going on and who would be looking over this thing, they ended up being fine and recognized that they benefited."* This positions procedural equity or the inclusion of stakeholders in decision-making, as a factor that increased buy-in for the decentralized systems.

Table 2*. Emergent themes and example excerpts from each of the three equity components (economic, environmental, social).*

Emergent Themes + Descriptions (Excerpts indicating that…)	***Examples***
ECONOMIC EQUITY	
Affordability. Costs associated with water technology systems (e.g. capital, O&M) contribute to equity.	*And the people that are operating it get a reduced cost to the customers using it. So that makes for a really nice mechanism to incentivize these [ONWS]. [Implicit, Operator]*
Willingness to Pay. Willingness of end users to pay for water recycling is a component of the equity discussion.	*[The utility] even asked [end users] if they'd be willing to pay more on their sewer bill to make more water recycling happen. [Implicit, Utility]*
Low-Income Exemptions. Providing exemptions for low-income end-users may improve the equity of ONWS.	*A [local government] agency has a water supply portfolio they can work with and they're going to save those cheaper supplies for those low-income people. [Explicit, Utility]*
Imbalanced Rate Structures. Every resident does not pay the same rate for the recycled water.	*Those [residents] with the money and the size are having to pay more simply because they can. [Explicit, Engineering Firm]*
Lack of Funding. Not enough investments are being made in ONWS and thus has prevented the adoption of equitable ONWS services.	*Some people have complained about, "Why aren't you more interested in funding decentralized systems?" [Implicit, Regulator]*
ENVIRONMENTAL EQUITY	
Maintaining Water Quality. Public health is dependent on water from ONWS meeting regulations.	*Put it this way: A failure that creates a public health consequence is a huge cost. [Implicit, Regulator]*
Resiliency of Systems. Improving the system to withstand natural and man made hazards that affect potable supply (e.g., droughts).	*If you can do some level of on-site water management, that's going to increase your capacity to stay up and running if we get the big earthquake, if we get the big flood that puts the centralized system out of operation. [Implicit, Regulator]*
Downstream impacts. ONWS should not create poor quality impacts that are pushed to neighborhoods downstream.	*The fact that [the regulatory agency] allowed all this permitting for kind of toxic industries to be right next to these neighborhoods. [Implicit, Government Agency]*
	In a lot of areas where [the building owners] are growing, we

Unsustainable Population Growth. Population growth is contributing to the inequities in water systems.	*feel the strain, the city feels the strain, often because these are cities that are growing already and feeling strain on all their infrastructure and their systems. [Implicit, Building Owner]*
SOCIAL EQUITY	
High- & Low-Income Earners Benefit from System. ONWS should be accessible to all income-earners to be equitable.	*So, it's not like it's only for the lower class, this [ONWS] was being done for the highest class. Which in my mind is a great way to move the social barriers forward, is to make it only for the best first so that it's shown as something desirable by everybody. [Implicit, Operator]*
Lack of Trust. Belief that the decision-makers are acting in the best interest of end users.	*There's a reason right now why Black and Brown and low-income minority and diverse communities have lost all their trust for public utilities. [Implicit, Government Agency]*
Public Engagement. Community and public participation in the decision-making processes is required for equity.	*Once [the public] understood what was going on and who would be looking over this thing, [the public] ended up being fine and recognized that they benefited. [Implicit, Utility]*
Lack of Information/Knowledge. The public is missing education and information on ONWS, thus creating barriers to implementation.	*I think [the regulatory agency has] created confusion, and people rely on the internet. If you go on the internet and try to find information on, "What do I need to do to do this right?" you don't get coherent information in a lot of places. [Implicit, Government Agency]*
Accessibility. ONWS are seen as not being accessible by all end-users.	*[Utilities] not inclusive for minority groups. They're not inclusive for people that speak multiple languages. [Implicit, Government Agency]...Inclusivity and accessibility is a big thing.[Implicit, Government Agency]*

Results represent both implicit and explicit expression of equity in decentralized water recycling systems (table 2). When explicitly asked about equity, a need for cohesive language was expressed. For instance, one stakeholder mentioned that '*when you talk about capacity development, we [stakeholder] owe more to the disadvantaged. How we define that in this setting is not totally clear to me*.' Thus, suggesting that the stakeholder has some understanding of the social component of equity. Implicitly, stakeholders made references to aspects of equity, for example, the need to maintain quality of basic service provision, acknowledging public mistrust in utilities, and accessibility to a diverse water portfolio (table 2). One stakeholder stated '*I want to point out that it is a nightmare for operations, for a uniform quality*,' when discussing the installation of ONWS. This excerpt highlights stakeholders implicitly think about components of the equity framework, even when not explicitly asked. Particularly this excerpt points to an understanding of environmental equity considerations such as uniform quality when operating ONWS.

In viewing equity from the perspective of the three pillars, it is evident from the data that there does not exist consistent overlap in the definitions used by stakeholders surveyed (table 2). Whether implicitly or explicitly discussing equity, the primary focus often centered on one of the three pillars and not a combination of the three. For instance, several stakeholders discussed the economic implications of equity such as affordability and the lack of funding (table 2). A

regulatory stakeholder stated "s*ome people have complained about, 'Why aren't you [Government] more interested in funding decentralized systems?'"* This highlights the need for fiscal stimulus to ensure that equitable access to ONWS exists. As the need for an expanded water portfolio grows, stakeholders will look to governments to assist in the adoption of ONWS. Other stakeholders were more interested in the environmental and social aspects of equity, specifically calling out issues such as water system resiliency and the inclusion of communities in the participatory processes in utility decision-making. This particular sentiment was expressed by a stakeholder, "*we're [Stakeholder] only going to have the wealthy luxury buildings to have rain water harvesting and toilet flushing, which then gives them resiliency in the event of a total breakdown of the infrastructure."* This indicates that there is inherent inequity in the current application of ONWS that is geared towards higher income earners. However, as suggested in the excerpt, ONWS provide an additional layer of water systems resiliency that should be accessible by all demographics. While these are critical aspects to equity, there remains an urgent and necessary need for integrating equity within planning and adoption of alternative water systems.

INITIAL FINDINGS AND IMPLICATIONS

Findings from this study show that equity is an afterthought that is still unclear for stakeholders. As shown in the stakeholder excerpts (table 2) a desire exists to be more equitable in the application and expansion of ONWS. However, reaching this goal is often constrained by unclear definitions, and the various different equity contexts that exist in the water sector. For instance, results highlight that a greater number of implicit excerpts discussing equity were recorded in the transcriptions. When equity was mentioned or asked explicitly, most interviewees struggled to contextualize a meaning within their work. Several stakeholders mentioned consequences resulting from inequitable approaches to adopting ONWS, such as a lack of redundancy and resiliency in centralized systems leading to quality issues and systems failure. Such consequences can be avoided through a proactive approach that incorporates procedural and distributive equity. By proactively integrating equity components in practice, utilities can move towards maintaining and improving systems with a more inclusive framework (UN 2020). While equity has been a point of conversation in the water sector, it has been limited to affordability, quality, and quantity within the network (Clumpner 2019; Teodoro 2005; Nauges and Whittington 2017).

The three major themes in literature (economic, environmental, social) are juxtaposed with the 14 emergent themes captured in analysis (table 2). This stark contrast emphasizes the need to further expand on working definitions of equity in the water sector and to embrace the complexity surrounding this topic. This echoes recent attempts to expand the definition of equity for local application and development (Osman and Faust, n.d.). An approachable framework for equity is missing, suggesting the need to reorganize how we are framing the concept in theory and application. Literature in sustainable development has already done this through the triple bottom line (economic, environmental, social). Using this baseline, and the notion that equity is already inherently built into the SDGs, we also use the framing of economic, environmental, and social equity.

The introduction of alternative water sources provides an opportunity to reevaluate the water sector's relationship with equity and to better integrate this concept within programming. Technology configurations such as on-site non-potable reuse is still working towards general validation, where regulations, programming, actor networks, and governance structures are in flux; such a project phase has limited path dependency and is more conducive towards integration of equity to an inherent point of discussion. The first step to operationalizing equity is its acknowledgement; this paper provides concrete definitions for the various components embedded within the equity discussion and demonstrates the ways in which equity is observed implicitly and explicitly in planning and adoption of new technology. This creates a foundational understanding for practitioners to assess their own operations and procedures.

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