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A socio-hydrological approach for incorporating gender into biophysical models and implications for water resources research

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ABSTRACT

Men and women interact with water resources and landscapes in different ways, and there are frequent criticisms that little research is undertaken across disciplines to address this issue. Biophysical scientists in particular struggle with how to integrate "gendered" water uses into models that are necessarily based on prevailing laws and equations that describe the movement of water through the hydrological cycle, independent of social constructs. We explore the challenges faced in developing interdisciplinary and transdisciplinary research approaches and then present a simple yet innovative socio-hydrological approach using participatory three-dimensional maps. As a case study, we describe undertaking this process in Ethiopia where two three-dimensional maps (men's and women's) were separately generated to represent the same 20 km^2 landscape. Mapping results indicated important distinctions in how men and women view landscapes with regard to the number and types of ecosystem services identified. For example, only women identified holy water sites along streams, while men identified twice as many sacred trees on the landscape. There was a clear focus and detailed knowledge about soils among participants in both groups. Maps developed as part of this exercise were successfully used as the principal land use input for the Soil and Water Assessment Tool (SWAT) and results indicate that this is a valid strategy that enhances scientific knowledge and understanding of overall landscapes and ultimately adds value to research for development questions.

1. Introduction

For most rural households throughout sub-Saharan Africa there is a lack of access to safe water resources on the premises, which results in women and children often walking long distances to procure enough water to fulfill even basic daily requirements (Pickering & Davis, 2012). While women are known to be the primary drawers of water across the African continent (Thompson et al., 2001), they also fill a complex and dominant role in agricultural activities that require access to and management of water resources, though they are often operating at the margins of society due to limited access to land, labor, and inputs (Doss, 1999). Fletschner and Kenney (2014) report that women's lack of access to financial markets and services – often a direct result of social norms and women's legal rights – represent a hindrance in rural development. In a study by Davis et al. (2012), however, the authors found that when given opportunities such as access to farmer field schools, women demonstrate greater gains than men in terms of increased and improved agricultural outputs. As a consequence, we see that such disparate access to resources and opportunities leads to men and women interacting with natural resources and landscapes in different ways.

Women in rural societies are disproportionately more impacted by the health and sustainability of ecosystems due to having livelihoods directly related to natural resources (Masika, 2002). As the principal drawers of water in many rural communities, it is well understood that women and girls face challenging physical circumstances on a near daily basis and that this has increased over the past three decades despite efforts to improve women's access to water (Thompson et al., 2001; White, Bradley, & White, 1972). In addition, women are overly reliant on livelihood practices where water productivity plays a key role (*e.g.*, domestic water needs, agricultural productivity, and biomass energy). The underlying assumption in development – that merely including women in water resources decision making groups leads to equitable

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access – misses the mark as it does not account for the social complexities governing water access, use, or management (Cleaver & Nyatsambo, 2011; Udry, 1996). It is now standard practice for development programs to be built upon "gender mainstreaming" approaches, but the result is often nothing more than satisfying a quota under the guise of "participation" (*e.g.*, having a certain number of women sit on management boards), rather than actual participation in or influence on decisions made (Brett, 2003; Cleaver & Nyatsambo, 2011; White, 1996). Cleaver and Nyatsambo (2011) point out that even in situations where men recognize the needs and constraints that women face, certain social responsibilities take precedent. They highlight an example where livestock may still have priority in water queues causing women to seek out other less desirable water sources despite men acknowledging that this places an undue burden on women in terms of time and health or safety issues.

Poor women and girls in rural areas are particularly at risk from the predicted impacts of climate change on water resources as, for example, they are required to walk further distances from their homes to find water resources (Lambrou & Piana, 2006; Masika, 2002). At the same time, women are often routinely absent from local decision making processes on how to mitigate or address impacts of climate change, as well as at the international level where few women water professionals are involved in negotiations by world governing bodies and governments (Masika, 2002). This lack of women water professionals is of particular concern. Feminist technology studies in recent years have called attention to the pervasive idea within societies of equating masculinity with technological or engineering fields of research (Faulkner, 2000). Women are expected to "fit in" to these fields and this alludes to an assumption that women with non-traditional approaches to technological and engineering challenges do not bring something unique or useful to bear on these research areas (Faulkner, 2000). As such, women's value systems and approaches to problem solving are missing at even the highest levels with ripple effects on research for development efforts.

A significant predicted consequence of climate change is an overall decrease in available water resources in many already water scarce regions (Vörösmarty, Green, Salisbury, & Lammers, 2000), which will result, for example, in increased physical labor undertaken by women and girls to fetch water required to meet daily household needs (Lambrou & Piana, 2006; Mellor, Watkins, & Mihelcic, 2012). Changes in climate that cause reduced precipitation may lead to an increased need for irrigation in many regions, though coincidently overall water resources scarcity will make productive water use availability low (Vörösmarty et al., 2000). Coupled with limited and complex access rights to land and other agricultural inputs (Doss, 1999; Snyder & Cullen, 2014), women are likely to suffer disproportionately with regard to water resources access (Cleaver & Nyatsambo, 2011). This will have a potentially cascading effect on food security in areas such as sub-Saharan Africa where women are responsible for up to 50% of the agricultural work force (FAO, 2011).

Identifying, including, and addressing the unique needs of women and their access to water resources is of a normative nature in that researchers are given explicit goals or measures of success for including women in water resources decision making (*e.g.*, millennium development goals and now the sustainable development goals), but no guidelines on how this ought to occur. This often leads to quota systems that do not involve any transformative changes within the system (Brett, 2003; White, 1996). To go beyond lip-service and make these goals truly actionable, socio-technological approaches are required that enable the development of novel transdisciplinary methods.

Ecosystem services are human defined in that they represent benefits derived by humanity from the natural environment (Daily, 1997; MA, 2005; TEEB, 2010; WLE, 2014). Ecosystem services are commonly divided into four distinct broad categories (TEEB, 2010; WLE, 2014):

- Provisioning services are obtained directly from an ecosystem and include benefits such as food, fresh water, fuel, construction materials, fiber, and medicines.
- Regulating services are those that result when ecosystem processes are controlled either by natural or artificial infrastructure and includes benefits such as flood mitigation, climate regulation, or water quality.
- Cultural services are comprised of both material and non-material benefits and can include aesthetic values of a landscape, spiritual places or opportunities to carry out ceremonies, and recreational activities.
- Habitat services are processes that support species life cycle maintenance and genetic diversity.

Many ecosystem services are mediated either directly or tangentially through access to water and have direct linkages to human well-being (Brauman, 2015).

From an ecosystem services standpoint, women are often consigned to accessing only marginal scarce resources. Small fluctuations in a system can affect resource availability and therefore access to a given service. For example, land use management that reduces water availability during the dry season can result in women and girls having to walk further to seek alternative sources, which in turn may impact how much water they are able collect as well as how much time they spend on other activities (Sorenson, Morssink, & Campos, 2011). Given these circumstances, rural women living in poverty are projected to be disproportionately impacted by factors such as climate change or policy changes that influence land management (Masika, 2002).

To address this challenge, there is an urgent need to identify critical ecosystem services and how they are utilized differently by men and women. A recent review of 92 research articles on ecosystem services comprising a database of 231 actual or potential tradeoffs found that not a single study disaggregated ecosystem services trade-offs across gender (Howe, Suich, Vira, & Mace, 2014). Consequently, the authors identified this lack of disaggregating trade-offs across gender as a major gap in ecosystem services assessments. Further, Brauman (2015) found that in an assessment of 381 peer-reviewed studies involving water related ecosystem services, few if any papers made the direct linkage among people and biophysical processes. In fact, the majority of studies assessed (93%) did not identify a beneficiary of the water related service being assessed. This immediately brings into question how services at the center of research questions were identified and defined in the first instance given the definition of ecosystem services is people oriented.

1.1. Multidisciplinary, interdisciplinary, and transdisciplinary research

While on the surface it appears that efforts are actively being undertaken to address challenges faced by the world's rural poor – particularly women – there is also mounting criticism that little research is successfully undertaken across disciplines (*e.g.*, interdisciplinary or multidisciplinary approaches) in such a way to truly address ecosystem services management and sustainability issues. Rather, research questions are being driven by myopic disciplinary approaches because they are simpler and perhaps less confrontational (Janssen & Goldsworthy, 1996; Uiterkamp & Vlek, 2007).