

# **Water sharing, reciprocity, and need: A comparative study of interhousehold water transfers in sub-Saharan Africa**

## **Abstract**

Water sharing between households could crucially mitigate short-term household water shortages, yet it is a vastly understudied phenomenon. Here we use comparative survey data from eight sites in seven sub-Saharan African countries (Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Malawi, Nigeria, and Uganda) to answer three questions: With whom do households share water? What is expected in return? And what roles do need and affordability play in shaping those transfers? We find that water is shared predominantly between neighbors, that transfers are more frequent when water is less available and less affordable, and that most sharing occurs with no expectation of direct payback. These findings identify water sharing, as a form of generalized reciprocity, to be a basic and consistent household coping strategy against shortages and unaffordability of water in sub-Saharan Africa.

## **Keywords**

Water; Water Insecurity; Household Economics; Sharing; Transfers; Reciprocity; Africa

## **Introduction**

Water is increasingly scarce and commodified. Across the globe, 4 billion people now experience severe water scarcity for at least one month of the year (Mekonnen and Hoekstra 2016). While household water need can be related to aridity or physical water scarcity, in contemporary societies it is additionally created by poor water governance, unreliable provision and maintenance, social marginality, lack of political power, lack of resources, and other aspects of living in poverty (Bakker 2010; Jepson et al. 2017; Swyngedouw 2013). Community pooling has been, historically, a widely practiced institutional strategy across the globe for managing scarce water resources for collective benefit at the local level (Guillet 1992; Lansing 1987; Scarborough 1998). To cope with water insecurities, vulnerable communities self-organize through such means as pooling money or labor to safeguard and allocate new water sources (e.g., digging wells or building a tap stand system) or by exerting governance rules around existing water sources to distribute water across households more equitably and consistently (Ostrom 1990).

However, such common pool water also can transform into a private good. For example, when people collect or buy water for their own household use, it may then be seen as belonging to the person or household that collected or purchased it, regardless of its provenance. As such, another potential form of coping with water shortfalls is the direct sharing of such private water between households; in other words, the acts of giving or receiving water from one household to another as gifts, loans, exchanges, or sales (Wutich and Brewis 2014; Wutich et al. 2018), sometimes operationally referred to as transfers. By household water sharing, we are referring to transfers of water between households designed to meet daily needs inside the receiving household (i.e., drinking, cooking, sanitation, washing clothes, cleaning, and bathing, but not maintaining livestock or crops). These transfers can be viewed as a kind of gift giving, with a potentially wide range of expectations of payback or reciprocity (Mauss [1924] 2002).

Following Sahlins (1972), we are particularly interested in understanding if expectations of reciprocity are better described as generalized reciprocity (with no expectation of direct or immediate payback) or balanced reciprocity (with a clear expectation of some form of payback on a relative short time scale). Social scientists have previously documented interhousehold water transfers occurring within low-resource communities in rural Ethiopia (Maes et al. 2018), Malawi (Adams 2017; Velzeboer, Hordijk, and Schwartz 2017), Sudan (Zug 2014; Zug and Graefe 2014), Uganda (Pearson et al. 2015), and Tanzania (Nganyanyuka et al. 2014).

A recent review proposes that such transfers should emerge with consistency in water-insecure environments, and this may reflect a broader strategy to mitigate some of the effects of managing unsafe, intermittent, or insufficient local water sources (Wutich et al. 2018). Yet, the lack of systematic documentation of water sharing practices as they occur across diverse sites means it is difficult, on the basis of the current empirical evidence, to theorize better what those might be and how they might mitigate resource risks (like water unaffordability). By comparison, there is good cross-cultural evidence that inter household food sharing (and, to some extent, labor sharing) emerges consistently under conditions of resource shortages, and that the greater the shortage, the more sharing that occurs (Ember et al. 2018).

Here we present an empirical, comparative, cross-cultural study designed to provide much-needed basic substantiation regarding how some key proximate household economic (e.g., water need/affordability) and social (e.g., cultural norms) factors shape household water sharing. Given the fundamental lack of existing theoretical literature explaining household water sharing as a practice to mitigate such water stresses, we begin with three key questions to organize our analysis: With whom do households share water? What is expected in return? And what role does need and unaffordability play in shaping those transfers? Our answers and resulting theory building are based on the systematic comparison of eight socially and economically distinct communities from across sub-Saharan Africa. Our research sites are characterized by significant rainfall seasonality, high levels of material poverty, weak water infrastructures, and other water-supply challenges. We chose the region to baseline test propositions regarding the general principles of how and why households share private water because many of the existing case reports of interhousehold water sharing events noted above are from this region.

We began our effort to clarify water sharing with a key question: why would people in water-insecure communities share household-owned water at all, especially when they themselves may also have need? The limited water sharing literature is not especially clear on this point (Wutich et al. 2018). Economic anthropologists, working from both sociocultural and evolutionary perspectives, though, have provided a variety of reasonable answers, particularly from studies of food sharing, that could be relevant. From research in behavioral ecology on food sharing in subsistence societies, we can posit, for example, that givers and receivers may set up a “tit-for-tat” reciprocal arrangement in which one provides water to the other at one time in exchange for a return gift at some point in the future (Axelrod 1984; Trivers 1971). In Namibia, for example, Schnegg and Linke (2015) found that people maintain complex networks that include noncommensurate exchanges of food and other goods, including water. But not all household trading partners are equal, and a further basic expectation drawn from the food sharing literature would be that kin (especially genetic kin) would be favored in transfers over affines (relatives by marriage), and both would be favored over friends and neighbors (Hamilton 1964, as discussed in Gurven 2004 on kin; see also Hruschka 2010). Family members are viewed generally as more reliable and trustworthy sharing partners, so they could be favored in “tit-for-tat” just

for the reason of higher expectation of later reciprocity (Allen-Arave, Gurven, and Hill 2008). Such favor could take the form of both higher frequencies of transfers and lower expectations of exchange/return. For example, water kiosk attendants in informal settlements of Lilongwe, Malawi, were observed to routinely offer free water (illegally) to their family members or people with whom they shared close ties (Adams, Juran, and Ajibade 2018). Thus we propose the following:

Proposition 1: Water sharing transfers will occur more frequently between closely related kin.

Proposition 2: Transfers are more likely to have no direct expectation of direct payback (i.e., generalized reciprocity) when they are between kin.

There is also a relevant growing literature regarding the role of generosity (Barnard and Woodburn 1988) and norms, often referred to as a moral economy, that is potentially relevant to water sharing (Trawick 2001; Wutich 2011). This includes the expectation to help those in need, and is especially evident in subsistence societies (e.g., Scott 1976). Such norms may dictate the giving of water to those who suffer from thirst or other immediate water needs (Wutich and Brewis 2014). Water sharing norms, which may be situated in religious communities and beliefs or other factors, have been described for contexts as varied as Syria and Saudi Arabia (Musil 1928), Tanzania (Smiley 2013), Bangladesh (Sultana 2011), and Bolivia (Wutich 2011).

Another possibility is that the donors and recipients who engage in water sharing events are engaged in risk-pooling relationships, whereby those who happen in that moment to have abundant resources give to those who are in need, reflecting the shared understanding that the future of one's resource acquisitions and holdings is unpredictable (Cronk et al., forthcoming; Velzeboer, Hordijk, and Schwartz 2017). In the case of water, such an arrangement would make sense if there were unpredictability as to which sharing party would be successful in obtaining water and which would not (e.g., Wiessner 1986; Wutich 2011); that is, related to unpredictability in each household's ability to access, afford, or transport water, rather than unpredictability in the overall availability of the resource. A further explanation is that people will share water because doing so serves as a sign of both their ability to acquire resources and their generosity, an idea common to both the theory of indirect reciprocity (Alexander 1987) and costly signaling theory (Smith and Bliege Bird 2005). Last, people may trade water for the simple, immediate reason of profit or cash earnings. In other words, water is seen as a commodity with a price, just as one might charge or request reimbursement from others for any private good.

Household economics—specifically need itself—should also theoretically matter greatly for shaping decisions around water transfers. Water sharing can thus be broadly approached as a coping strategy in the face of economic constraints—without losing sight of the importance of inequality—including in access to water, negotiating power, and household economic inequalities. This perspective can sit comfortably with varied forms of generosity and moral economies. For example, wealthier households might share water with those in greatest need to build political capital or to reinforce patron–client dependencies (i.e., perform self-interested charity) (Wutich et al. 2018). In this vein, Pearson et al.'s (2015) observations in three rural Ugandan villages noted that wealthier, higher-status households tended to gift water to the poorer and lowest ones (who were more likely to be forced to purchase water).

In this arrangement, households in the middle were mostly excluded. Alternatively, in Bolivian squatter settlements, Jewell and Wutich (2011) observed that the most severely water-deprived households sometimes withdrew from requesting water from others if they thought any later reciprocity might be expected (Wutich and Ragsdale 2008). Because worry of having to repay after accepting water is a demonstrated stressor, we need to better test if it is really the case that the most extreme need leads to the high densities of water sharing. Thus we propose the following:

Proposition 3: Both need for water and unaffordability of water will predict a greater rate of interhousehold water transfers.

Proposition 4: Households with higher socioeconomic status (SES) within communities will transfer preferentially to households with lower SES and will be more likely to do so without an expectation of direct payback (i.e., generalized reciprocity).

### **Study details**

The data analyzed herein are drawn from the Household Water Insecurity Experiences (HWISE) study. The initial round of data collection included household survey implementation at eight different sites across sub-Saharan Africa, with a target sample of 250 households at each site (Table 1). The selected study sites span an array of urban, periurban, and rural settings. All sites experience various forms, degrees, and etiologies of water insecurity, for example seasonality, infrastructure, or service challenges (see Tables 1 and 2). The forms of water transfer vary across the locations but mostly involve relatively modest amounts that can be carried. For example, in the Ugandan site, in-home piped water is unavailable. Household water must be collected in a jerry can from a public borehole, a surface water source, or (more rarely) a water vendor. Water transfers across households thus typically involve handing over one or more jerry cans of water or permitting other households to fill jerry cans from a pond or stream on a household's private property. At the Malawi site, private household taps are rare, and water collection involves walking to either a water vendor or a public standpipe. Water is then stored within the household in barrels or large basins to guard against intermittent supply and sudden breaks in the distribution system. Water transfers across households typically involve giving away one or more bucketsful of water from this stored supply. Transfers can also take the form of more affluent households with their own taps allowing poorer households to take buckets of water from the tap at no cost. Data collection at each site was managed by social scientists (mostly trained as anthropologists and cultural geographers), each with long-term experience at that particular site. Verbal informed consent was obtained at the beginning of all interviews by a trained enumerator. Individual site principal investigators' (PIs') home institutions or Northwestern University (central manager) provided the institutional review board of record for the sites. Furthermore, ethical approval was obtained as required from the appropriate local or national in-country institutions. Systematic random sampling was used to select households for participation, except in Kahemba, Democratic Republic of Congo (DRC), where the survey was implemented within an ongoing intervention study that utilized a purposive sampling technique (Table 1). Adults who described themselves as knowledgeable about the household's water situation were considered eligible to participate. Surveys were administered in the relevant local language.

Table 1 here

Topics included questions on sociodemographics, water acquisition, treatment, and water storage. In terms of water sharing, the respondent in each household was asked “In the last four weeks/month, how frequently have you or anyone in your household asked to borrow water from other people? From whom? What was expected in return?” and “In the last four weeks/one month, how frequently have you or anyone in your household loaned water to anyone?” To understand who shares with whom, we coded open-ended responses into relationship distance categories (i.e., family, friends, neighbors, etc.). Where people nominated multiplex ties (e.g., neighboring family member), we coded for the closer relationship (e.g., family member over neighbor). Level of absolute household need for water was estimated based on four factors—(a) reported frequency of no water whatsoever in the household, (b) worry about not having enough water, (c) interruption of water supply, and (d) not enough water as would like to drink in the last four weeks—on a 5-point scale ranging from 0 (never [0 times]) to 4 (always [more than 20 times]) then summed (range 0–14, mean 2.6±3). We then created an ordinal variable using natural breaks in the data to define cut points, so that none=0 (24% of observations), low=1–3 (30%), medium=4–6 (25%), and high=7–14 (21%). A measure of absolute household water unaffordability was derived from reporting frequencies of lacking money to buy water (never, rarely, sometimes, often, always), reporting of frequencies of money concerns about water, monthly spending on securing water as a percentage of total household income (in USD), and level of reported household food insecurity (using the Household Food Insecurity Access Scale; see Coates et al. 2007). A single component was extracted through principal components analysis, explaining 52.5% of variation (see Table 2 for variation by site). To consider relative perceived SES, respondents were asked to point to a rung on a ladder to indicate their household’s relative socioeconomic standing compared to others in their local community.

The scores ranged from 1 (highest standing) to 10 (lowest standing). To allow Water Sharing, Reciprocity, and Need comparisons across sites related to relative status within sites, we converted these site-specific measures to quintiles within each site (with 1 being the lowest perceived SES quintile and 5 the highest). Descriptive analyses were conducted in SPSS version 24. For predictive modeling, multiple logistic regression models were used since our outcome variables (giving water, receiving water, and expectation of return) were dichotomous. These models, when estimates are exponentiated, provide odds ratios (OR). All regression models were estimated using Stata Version 15.0 and included the following covariates: rural versus urban/periurban, household size, time spent collecting water each week (greater vs. less than one hour per day on average), amount of drinking and total water stored in the household, and whether the main household water supply was being purchased at the time of data collection (e.g., tanker truck, bottled water). These covariates were selected a priori based on documented factors that affect water availability and needs within households, which may affect the giving and receiving of water (Gleick 1996; World Health Organization 2017). Our independent variables of interest, fitted into the separate models, were whether recipients of transfers were kin, household water need score, water unaffordability score, and relative SES quintiles. We used variance inflation factor (VIF) to assess potential multicollinearity present within regression models. All covariates had VIF lower than 10, indicating that multicollinearity was not significantly affecting the estimates (Wooldridge 2015).

Table 2 here

We accounted for clustering across the eight sub-Saharan sites in two ways. First, we used a fixed-effect estimation technique to account for site-level differences since we had insufficient sample size at our macro-level unit (i.e., sites,  $N < 25$ ), and the sites themselves

were not chosen at random from all possible sites in sub-Saharan Africa (Möhring 2012; Wooldridge 2015). Using hierarchical regression modeling in this situation may result in omitted variable bias regarding the site-level estimators. Therefore, using a fixed effect for our macro-level unit, we dealt with this issue by controlling for site-level heterogeneity and removing variation at the site level. Second, we employed cluster-adjusted standard errors to account for within-cluster (site) correlation, relaxing the independence requirement of observations (Wooldridge 2015).

We note two key limitations of these analyses. While the site samples all involved random selection at the household level, three sites also first stratified by clusters (population strata, neighborhoods, or towns). This means that our standard errors are underestimated. For this reason, we more conservatively selected  $p < 0.01$  as our threshold for significance. Second, some sites obtained samples above the target of 250 (e.g., DRC at  $n=392$ ). This means that it would be possible that our findings would be biased toward the observations at the locations with larger contributing sample sizes. For this reason, we used probability weights in the regression modeling described earlier to adjust for sample size within each site to the target goal of 250 as the inverse probability that an observation was sampled (Korn and Graubard 2011). For example, in the DRC, each observation was weighted as  $1/(392/250)=0.638$ .

## Results

Figure 1 here

Interhousehold water sharing (i.e., transfers) occurs regularly at all the surveyed sites (see Figure 1). Rates of households giving water in the prior four weeks ranged from 6.4% in Arua, Uganda, to 66.7% in Kisumu, Kenya (both rural, primarily agriculturalist communities). Rates of incoming water transfers (i.e., receiving) ranged from 20.5% in urban Accra, Ghana, in the rainy season to 84.8% in rural agropastoralist villages of Kahemba, DRC (the site with reportedly the most chronic water shortages of all those sampled).

Water transfer patterns were more evenly balanced in some sites than others, meaning that the percentage of households that gave water better balanced those that received water (Table 2). While we do not have data that track directly the reciprocity of transfers between specific households, the range of lending households that also themselves received water in the last four weeks was as low as 32.5% in urban Accra, Ghana, to 94.8% in Kahemba, DRC. Importantly, Kahemba is also the site with the highest levels of giving and receiving and the most balanced and getting “in the last four weeks”, by site.

Figure 2 here

What was expected in return for getting water, as reported by site. pattern of giving and receiving. Furthermore, in the site with the lowest rate of households giving water (Arua, Uganda, 6.4%), three-quarters of those giving households also reported receiving water themselves, another indirect indicator of a reciprocal system in operation.

Proposition 1: Do households share most frequently with kin?

Contrary to expectations, the vast majority of extra household transfers in all the sites were with nonkin, specifically with neighbors (87% overall, ranging from 52% to 93%; Table 2). The highest rates of transfers between kin were in Amhara, Ethiopia (48%), a rural site of

unbalanced transfers with many more households getting than giving water, and rural Arua, Uganda (32.5%), the latter also with relatively high levels of unbalanced transfers (i.e., a few households were transferring water to many).

Proposition 2: Is water sharing with kin more likely to be generalized reciprocity?

The vast majority of water transfers into households overall (77.3%) were described as generalized reciprocity, in that nothing was expected in return (Figure 2). In two sites (Lagos, Nigeria, and Kampala, Uganda), some form of payback (i.e., balanced reciprocity) was expected more commonly than generalized reciprocity. In Lagos, Nigeria, water was expected in return, and in Kampala, Uganda, water or money was expected. Notably, reports of expectations of payback for water sharing in forms other than water or money (e.g., food, labor) were extremely rare (Figure 2). We then used logistic regression to test if transfers with kin were more likely to have no expectation of return (i.e., were generalized reciprocity) (Table 3). We found that kin were not significantly different than nonkin in the expectation of return of water ( $p=0.19$ ). However, the relationship was in the expected direction, as kin had half (0.49) the odds of expecting something in return for receiving water compared to nonkin (95% CI 0.19–1.40, Model 1) adjusting for covariates.

Proposition 3: Does household water neediness/unaffordability affect sharing?

We considered how levels of household need for water affect the likelihood of transfers. Water need scores were highest on average in Kahemba, DRC ( $6.3 \pm 2.9$ ), and lowest in Lagos, Nigeria ( $1.1 \pm 1.7$ ) (Table 2). The large standard deviations reflect significant within-site inequalities in need. We tested if households with greater need for water were more likely to receive water and if those with lower need for water were more likely to give it (Model 2, Table 3). We found strong evidence on both counts, such that as household need increased, the odds of receiving and giving water grew in magnitude. Most notably, households who reported the highest need for water had nearly 9 (OR 8.8, 95% CI 3.99–19.4,  $p<0.001$ , Model 2a) times the odds of receiving water and 4.5 (OR 4.63; 95% CI 2.25–9.51,  $p<0.001$ , Model 2b) times the odds of giving water to other households, compared to those with no reported need for water and adjusting for covariates.

We used a similar logistic regression model to test if water unaffordability also affected who received and gave water (Model 3, Table 3). We found that as water unaffordability increased, so did the odds of both giving and receiving water in the past month. Specifically, each standard deviation increase in the water unaffordability score was associated with 2 (95% CI 1.71–2.32,  $p<0.001$ , Model 3a) times the odds of receiving water and 1.5 (95% CI 1.23–1.83,  $p<0.001$ , Model 3b) times the odds of giving water, controlling for covariates.

Table 3 here

Proposition 4: Does perceived household SES affect sharing?

Mean perceived SES scores varied across sites, with households in Kahemba, DRC, estimating themselves with the worst SES on average ( $8.0 \pm 1.6$ ) and those in Lagos, Nigeria, with the highest estimates ( $5.4 \pm 2.1$ ). Considering data from across all the sites, lowest quintile SES households within each site had higher reports of receiving water within the last month, and the highest two quintiles reported the least. And while the sample sizes are small, an apparent trend can be seen among the fourteen respondents who reported “frequently” receiving water within the past month: more than half were within

the lowest quintile, while only two were in the highest. However, households within all SES quintiles reported receiving water, and there was no clear linear trend (first [lowest]=26%, second=19%, third=22%, fourth=17%, fifth [highest]=17%). Similarly, for water giving, some households at all SES quintiles within sites reported doing so (first=22%, second=16.9%, third=21%, fourth=19%, fifth=21%), again with no clear linear trend. The third and fifth quintiles were most likely to report “always” having given water in the past month. However, the lowest quintile was the most likely to report “often” giving, compared to others, with 39% giving water—the highest of the frequencies reported.

Giving and receiving patterns within sites also did not display evident linear trends (Table 2). In several sites, the middle quintiles were as likely to report having received or given water as the lowest or highest quintiles. For example, in Arua, Uganda, the middle quintile reported more than double the rate of giving water to other households than any other strata (44% of all transfers). In the DRC site, the lowest quintile reported giving water most frequently (25% of all transfers). In Accra, Ghana, the lowest and highest quintiles reported the highest frequencies of water sharing.

We used logistic regression models to test if relative perceived household SES status within sites predicted both giving and receiving water (Model 4, Table 3). Specifically, we considered if households in the top (highest) quintile(s) of perceived status were more likely to preferentially transfer water (Model 4) and whether those water transfers were made without expectation of payback to the bottom/lower quintiles (Model 5). We found that compared to the highest quintile, households in the lowest quintile had 60% higher odds of receiving a transfer (OR 1.60, 95% CI 1.20–2.13,  $p=0.001$ , Model 4a) in the last month. Households in the second lowest and middle SES quintiles also had elevated odds of receiving a transfer, but these did not meet our conservative significance cutoff.

In contrast, providing a transfer was not significantly different by quintile of SES, again due to our conservative significance cutoff (Model 4b). Finally, SES status by quintile was not associated with providing water without expectation of payback (Model 5). Implications, limitations, and next steps We began with four general propositions: that household water sharing transfers (a) would favor kin and (b) be more likely to engage in generalized reciprocity with kin, (c) that absolute need for water and unaffordability of water predicts transfers, and that (d) higher-status households will transfer to lower-status ones (without expectations of direct payback). Integrating the findings of our analyses of empirical data from eight sub-Saharan African sites provides several key insights relevant to general theory building around how proximate economic and social factors help explain household water sharing practices.

A key finding, against prediction, is that the vast majority of sharing events occur between neighbors, not kin. This has very significant theoretical implications, as it suggests that the key findings about kin preferences in the food-sharing literature (e.g., Gurven 2004; Hamilton 1964) are not directly generalizable to water sharing. A parsimonious explanation could be that water, compared to such other possible transferable household private goods as food, labor, or money, is heavy and hard to move—even to the point of causing injuries (Geere et al. 2010). That is, it is harder to move water between households in any volume without special transport or infrastructure (e.g., a tanker, pushcart), and the difficulty increases sharply with distance. The very high rates of sharing with neighbors suggest to us that the forms of water sharing networks within communities are likely driven strongly by propinquity. A second explanation may be that sharing with neighbors who are nonkin may help strengthen bonds so that the sharers’ network is larger and they may have more people to call on when in need. This then suggests the need for detailed



case studies on this point. In this study, we do not know the actual amount of A. Brewis et al. water being shared, just the frequencies of sharing events. It could be that amounts of water given with or without expectation of payback vary between kin and nonkin households in important ways (e.g., perhaps transfers between kin are larger in volume when they occur, even if they are less frequent).

Importantly, the vast majority of reported water transfers—including between neighbors—were described as generalized reciprocity, for which no direct payback was expected. This was the same general pattern across low and high-SES households. At some sites, almost all transfers took this basic form. This is also consistent with the findings of the “moral economy” literature (Scott 1976; Trawick 2001; Wutich 2011) and also the idea that it is adaptive to give water to those who need it without any expectation of repayment in situations where there is some unpredictability about who will have sufficient water at any given time (Cronk et al., forthcoming; Wiessner 1986).

The unpredictability of such situations makes them similar to the kinds of situations in which one might buy an insurance policy. The norms found at many sites may thus be proximate cultural instantiations of this more distal adaptive logic of risk pooling through transfers to those in need (Aktipis et al. 2016; Cronk et al., forthcoming). In others, balanced reciprocity (i.e., direct payback for water) was sometimes expected. The two highest of these were both urban settings: in Lagos, Nigeria, almost half of water transfers were with an overt expectation of later payback with water in return, and in Kampala, Uganda, where one-third of transfers were expected in return. But in Kahemba, DRC, where neediness was greatest, only 5% of transfers included any expectation of return. In no sites, though, was there significant reporting of any other forms of payback, such as for labor or food for water. More detailed studies on this specific point are suggested, perhaps particularly comparing how food versus water transfers occur within communities struggling with both. Food security often depends on water security, while the converse is not true (i.e., you cannot cultivate food nor cook it easily without water). This might help explain why norms associated with generalized reciprocity seem to be so widely in effect across all these varied sites.

These data demonstrate, as predicted (following Pearson et al. 2015; Wutich 2011), that household economic factors are important in shaping water sharing practices. Overall patterns conform to those that would be expected if household sharing were a coping strategy to help deal with issues of water need or unaffordability. The site with the highest household levels of reported water need and unaffordability (Kahemba, DRC) also has both the highest rate of incoming water transfers, which makes sense given data were collected in the dry season. Moreover, modeling of data across the sites (with sites as fixed effects) confirmed that the odds of both receiving and giving a transfer increased substantially with increasing levels of household water need and water unaffordability. Notably, however, transfers of water—both giving and receiving—were observable at all perceived SES strata.

As predicted (Wutich et al. 2018), we found a general pattern of more transfers from higher-status households to lower-status ones; however, this was not uniformly replicated in every community. In some places, the lowest quintile households were given less water compared to those in higher quintiles. In other sites, households in the middle SES strata (third quintile) included those most actively engaged in water transfers. The general implication is that water sharing practices transect all social strata in water-scarce communities. These findings also indicate that much more detailed case study analysis

(like that suggested by Pearson et al. 2015) will be needed to understand how inequalities in household socioeconomics shape water transfer decisions.

A few limitations of the current study should be acknowledged. First, although we made an effort to capture multiplexity, our models did not include complex operationalizations of multiplex ties (e.g., kin who are also neighbors who are also coreligionists). More and better-defined research on multiplexity in water sharing is needed (see Schnegg and Linke 2015 for guidance here). For example, we need to better understand how kinship distance and household distance both matter. Second, it is possible that our finding about the relatively low rates of water sharing between kin (as compared with neighbors) could be an artifact of the way the water sharing questions were asked (i.e., using the terms loan and borrow). It is possible that people have unique emic concepts that describe water sharing with kin, and we would have received different answers if we had asked about these specifically. That said, many people did report water sharing with kin, and there are theoretical reasons (related to distance and the weight of water) that make it reasonable that neighbors would be preferred water sharing partners. Third, the data were not collected at the height of the dry season in most sites, and this may have contributed to underestimation of actual water sharing frequencies. Fourth, the concept of “sharing” varies across cultures and languages, and—although we made extensive efforts to pretest our protocols for cross-cultural equivalence—we cannot be completely sure that our core questions were understood in exactly the same way in each site. Finally, and relatedly, the high frequency with which water transfers between households are observed in all these water-scarce communities and that fewer people than predicted are sharing with their kin suggest the possibility of high levels of water sharing associated tensions and conflicts (not captured in this study). This is because, although the idea of “sharing” is commonly understood as synonymous with largesse, sharing, gift giving, and other resource transfers also can be deployed to (re)produce unequal power relationships. Sharing itself, in all its forms (gifting, selling, loaning, and so on) can also lead to disputes, as Sultana (2011) describes, especially in settings where water conflicts arise through class, power, religious, or political differences. We suggest that more detailed ethnographic studies of how conflicts around household water sharing systems emerge and are managed between households and within communities are a high priority.

## Note

1 The detailed HWISE data collection manual can be found online at <https://doi.org/10.21985/N2P450>.

## References

- Adams, Ellis A. 2017. “Thirsty Slums in African Cities: Household Water Insecurity in Urban Informal Settlements of Lilongwe, Malawi.” *International Journal of Water Resources Development* 34(6): 869–87.
- Adams, Ellis A., Luke Juran, and Idowu Ajibade. 2018. “‘Spaces of Exclusion’ in Community Water Governance: A Feminist Political Ecology of Gender and Participation in Malawi’s Urban Water User Associations.” *Geoforum* 95: 133–42.
- Aktipis, Athena, Rolando de Aguiar, Anna Flaherty, Padmini Iyer, Dennis Sonkoi, and Lee Cronk. 2016. “Cooperation in an Uncertain World: For the Maasai of East Africa, Need-Based Transfers Outperform Account-Keeping in Volatile Environments.” *Human Ecology* 44(3): 353–64.
- Alexander, Richard D. 1987. *The Biology of Moral Systems*. New York: Aldine de Gruyter.
- Allen-Arave, Wesley, Michael Gurven, and Kim Hill. 2008. “Reciprocal Altruism, Rather

than Kin Selection, Maintains Nepotistic Food Transfers on an Ache Reservation.” *Evolution and Human Behavior* 29(5): 305–18.

Axelrod, R., and W. D. Hamilton. 1984. *The Evolution of Cooperation*. New York: Basic Books.

Bakker, Karen. 2010. *Privatizing Water: Governance Failure and the World’s Urban Water Crisis*. Ithaca, NY: Cornell University Press.

Barnard, Alan, James Woodburn, T. Ingold, and D. Riches. 1988. “Introduction.” In *Hunter and Gatherers 2: Property, Power, and Ideology*, edited by A. Barnard, J. Woodburn, T. Ingold, and D. Riches, 4–31. New York: Bloomsbury Academic.

Coates, Jennifer, Anne Swindale, and Paula Bilinsky. 2007. *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide*. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Cronk, Lee, Colette Berbesque, Thomas Conte, Matthew Gervais, Padmini Iyer, Brigid McCarthy, Dennis Sonkoi, Cathryn Townsend, and Athena Aktipis. Forthcoming. “Managing Risk through Cooperation: Need-Based Transfers and Risk Pooling among the Societies of the Human Generosity Project.” In *Global Perspectives on Long-Term Community Resource Management*, edited by Ludomir R. Lozny and Thomas H. McGovern. New York: Springer.

Ember, Carol R., Ian Skoggard, Erik J. Ringen, and Megan Farrer. 2018. “Our Better Nature: Does Resource Stress Predict Beyond-Household Sharing?” *Evolution and Human Behavior* 39(4): 380–91.

Geere, J. L., M. M. Mokoena, P. Jagals, F. Poland, and S. Hartley. 2010. “How Do Children Perceive Health to Be Affected by Domestic Water Carrying? Qualitative Findings from a Mixed Methods Study in Rural South Africa.” *Child: Care, Health and Development* 36(6): 818–26.

Gleick, Peter H. 1996. “Basic Water Requirements for Human Activities: Meeting Basic Needs.” *Water International* 21(2): 83–92.

Guillet, David W. 1992. *Covering Ground: Communal Water Management and the State in the Peruvian Highlands*. Ann Arbor: University of Michigan Press.

Gurven, Michael. 2004. “To Give and to Give Not: The Behavioral Ecology of Human Food Transfers.” *Behavioral and Brain Sciences* 27(4): 543–59.

Hamilton, William D. 1964. “The Genetical Evolution of Social Behaviour. II.” *Journal of Theoretical Biology* 7(1): 17–52.

Hruschka, Daniel J. 2010. *Friendship: Development, Ecology, and Evolution of a Relationship*. Berkeley: University of California Press.

Jepson, Wendy E., Amber Wutich, Shalean M. Collins, Godfred O. Boateng, and Sera L. Young. 2017. “Progress in Household Water Insecurity Metrics: A Cross-Disciplinary Approach.” *Wiley Interdisciplinary Reviews: Water* 4(3): e1214.

Jewell, Benjamin, and Amber Wutich. 2011. “Charitable Christians, Punitive Neighbors: Religiosity and Economic Norms in a Water-Scarce Environment.” In *The Economics of Religion: Anthropological Approaches*, edited by L. Obadia and D. C. Wood, 307–37. Bingley, UK: Emerald Group.

Korn, Edward L., and Barry I. Graubard. 2011. *Analysis of Health Surveys*. Vol. 323. Hoboken, NJ: Wiley.

Lansing, J. Stephen. 1987. “Balinese ‘Water Temples’ and the Management of Irrigation.” *American Anthropologist* 89(2): 326–41.

Maes, Kenneth, Svea Closser, Yihnew Tesfaye, Yasmine Gilbert, and Roza Abesha. 2018. “Volunteers in Ethiopia’s Women’s Development Army Are More Deprived and Distressed Than Their Neighbors: Cross-Sectional Survey Data from Rural Ethiopia.” *BMC Public Health* 18: 258.

- Mauss, Marcel. (1924) 2002. *The Gift: The Form and Reason for Exchange in Archaic Societies*. New York: Routledge.
- Mekonnen, Mesfin M., and Arjen Y. Hoekstra. 2016. "Four Billion People Facing Severe Water Scarcity." *Science Advances* 2(2): e1500323.
- Möhring, Katja. 2012. "The Fixed Effects Approach as Alternative to Multilevel Models for Cross-National Analyses." Paper presented at the 10th ESPAnet Conference, Edinburgh, UK.
- Musil, Alois. 1928. *The Manners and Customs of the Rwala Bedouins*. New York: AMS Press.
- Nganyanyuka, Kapongola, Javier Martinez, Anna Wesselink, Juma H. Lungo, and Yola Georgiadou. 2014. "Assessing Water Services in Dar es Salaam: Are We Counting What Counts?" *Habitat International* 44: 358–66.
- Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. New York: Cambridge University Press.
- Pearson, Amber L., Jonathan D. Mayer, and David J. Bradley. 2015. "Coping with Household Water Scarcity in the Savannah Today: Implications for Health and Climate Change into the Future." *Earth Interactions* 19(8): 1–14.
- Sahlins, Marshall. 1972. *Stone Age Economics*. New York: Routledge.
- Scarborough, Vernon L. 1998. "Ecology and Ritual: Water Management and the Maya." *Latin American Antiquity* 9(2): 135–59.
- Schnegg, Michael, and Theresa Linke. 2015. "Living Institutions: Sharing and Sanctioning Water among Pastoralists in Namibia." *World Development* 68: 205–14.
- Scott, James C. 1976. *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia*. New Haven, CT: Yale University Press.
- Smiley, Sarah L. 2013. "Complexities of Water Access in Dar es Salaam, Tanzania." *Applied Geography* 41: 132–38.
- Smith, Eric A., and Rebecca Bliege Bird. 2005. "Costly Signaling and Cooperative Behavior." In *Moral Sentiments and Material Interests: The Foundations of Cooperation in Economic Life*, edited by Herbert Gintis, Samuel Bowles, Robert Boyd, and Ernst Fehr, 115–48. Cambridge, MA: MIT Press.
- Sultana, Farhana. 2011. "Water, Culture, and Gender: An Analysis from Bangladesh." In *Water, Cultural Diversity, and Global Environmental Change*, edited by Lisa Hiwasaki, Irene J. Klaver, Barbara Rose Johnston, Ameyali Ramos Castillo, and Veronica Strang, 237–52. New York: Springer.
- Swyngedouw, Erik. 2013. "UN Water Report 2012: Depoliticizing Water." *Development and Change* 44(3): 823–35.
- Trawick, Paul. 2001. "The Moral Economy of Water: Equity and Antiquity in the Andean Commons." *American Anthropologist* 103(2): 361–79.
- Trivers, Robert L. 1971. "The Evolution of Reciprocal Altruism." *Quarterly Review of Biology* 46(1): 35–57.
- Velzeboer, Linda, Michaela Hodijk, and Klaas Schwartz. 2017. "Water Is Life in a Life without Water: Power and Everyday Water Practices in Lilongwe, Malawi." *Habitat International* 73: 119–28.
- Wiessner, Polly. 1986. "!Kung San Networks in a Generational Perspective." In *The Past and Future of !Kung Ethnography: Critical Reflections and Symbolic Perspectives—Essays in Honour of Lorna Marshall*, edited by Megan Biesele, 103–36. Hamburg, Germany: Helmut Buske.
- Wooldridge, Jeffrey M. 2015. *Introductory Econometrics: A Modern Approach*. Mason, OH: Nelson Education.
- World Health Organization and UNICEF. 2017. *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines*. Geneva: World Health Organization and the United Nations Children's Fund.

Wutich, Amber. 2011. "The Moral Economy of Water Reexamined: Reciprocity, Water Insecurity, and Urban Survival in Cochabamba, Bolivia." *Journal of Anthropological Research* 67(1): 5–26.

Wutich, Amber, and Alexandra Brewis. 2014. "Food, Water, and Scarcity: Toward a Broader Anthropology of Resource Insecurity." *Current Anthropology* 55(4): 444–68.

Wutich, Amber, Jessica Budds, Wendy Jepson, Leila Harris, Ellis Adams, Alexandra Brewis, Lee Cronk, et al. 2018. "Household Water Sharing: A Review of Water Gifts, Exchanges, and Transfers across Cultures." *Wiley Interdisciplinary Reviews—Water* 5(6): e1309.

Wutich, Amber, and Katherine Ragsdale. 2008. "Water Insecurity and Emotional Distress: Coping with Supply, Access, and Seasonal Variability of Water in a Bolivian Squatter Settlement." *Social Science and Medicine* 67(12): 2116–25.

Zug, Sebastian. 2014. *The Gift of Water: Bourdieusian Capital Exchange and Moral Entitlements in a Neighbourhood of Khartoum*. Vol. 11. Zurich, Switzerland: LIT Verlag Münster.

Zug, Sebastian, and O. Graefe. 2014. "The Gift of Water: Social Redistribution of Water among Neighbours in Khartoum." *Water Alternatives* 7(1): 140–59.