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Food, Water, and Scarcity

Toward a Broader Anthropology of Resource Insecurity

by Amber Wutich and Alexandra Brewis

Food and water shortages are two of the greatest challenges facing humans in the coming century. While our theoretical understanding of how humans become vulnerable to and cope with hunger is relatively well developed, anthropological research on parallel problems in the water domain is limited. By carefully considering well-established propositions derived from the food literature against what is known about water, our goal in this essay is to advance identifying, theorizing, and testing a broader anthropology of resource insecurity. Our analysis focuses on (1) the causes of resource insecurity at the community level, (2) "coping" responses to resource insecurity at the household level, and (3) the effect of insecurity on emotional well-being and mental health at the individual level. Based on our findings, we argue that human experiences of food and water insecurity are sufficiently similar to facilitate a broader theory of resource insecurity, including in how households and individuals cope. There are also important differences between food and water insecurity, including the role of structural factors (such as markets) in creating community-level vulnerabilities. These suggest food and water insecurity may also produce household struggles and individual suffering along independent pathways.

Today, insufficient food and water are recognized as two of the greatest natural resource—and social justice—challenges that many communities will encounter in the current century (Butterly and Sheperd 2010; Donahue and Johnston 1998; Whiteford and Whiteford 2005). Old approaches to confronting these problems are failing because of the new institutional, climatic, and demographic challenges we face (Devereux 2007; Vörösmarty et al. 2010). As a result, there is an urgent need for anthropologists to develop novel approaches to understanding and addressing food and water insecurity. Understanding how humans meet their basic needs for food and water—and what happens, biologically and socially, when they cannot do so—has long been a driver of theoretical developments in anthropology (e.g., Halstead and O'Shea 1989; Harris 1968) and remain of vital importance to cultural anthropologists, archaeologists, and biological anthropologists alike.

In this essay, we argue for the potential of a literature that bridges anthropologists' theoretical understanding of food and water as basic resources necessary for human survival. While theories of how humans become vulnerable to and cope with hunger and food needs are relatively well developed (Hadley and Crooks 2012), parallel understandings around water are limited (Orlove and Caton 2010). By carefully considering well-established propositions derived from the food literature against the ethnographic, historic, and biocultural evidence on water, our goal is to identify and better articulate and understand important commonalities and points of difference. As we will show, this provides a better evidential base for moving forward in identifying, theorizing, and testing a broader anthropology of the causes and consequences of resource insecurity.

Given the possible existence of important parallel trajectories in the conceptualization of food and water insecurity, we posit that parallels also might be identified in our theoretical understanding of the causes and consequences of these phenomena at the community, household, and individual level. By examining phenomena at all three levels, one aim is to move our understandings beyond particular resources or singular ethnographic cases to identify and advance some key theoretical propositions regarding how humans experience resource insecurity. Thus, we focus on three key questions, each at a different level of analysis: (1) What are the most powerful drivers shaping community vulnerabilities to resource insecurity? (2) What household strategies appear to be most effective at coping with resource insecurity? (3) What are the biocultural costs of the coping process—that is, what happens when individuals are pushed beyond their capacity to respond effectively?

To begin, however, we need to define scarcity and insecurity as operational concepts. Scarcity refers to the absence of sufficient resources to support human needs (Durham 1979). The Food and Agriculture Organization issues (FAO) guidelines establishing basic human caloric and nutritional needs

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for infants, children, pregnant women, and other adults (FAO 2001). Human water needs are, minimally, 3–7 L per capita daily (lpcd) for drinking and 50+ lpcd for consumption and household use (Gleick 1996; WHO 2005). Insecurity is a broader, multifaceted concept that encompasses resource scarcity, resource access, and lifestyle concerns (Hadley and Wutich 2009). The FAO (2002) defines food security as "a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Following the FAO, Webb and Iskandarani (1998) defined water security as "access by all individuals at all times to sufficient safe water for a healthy and productive life." Resource scarcity estimates indicate that, globally, 870 million people experience chronic hunger (FAO 2012) and that 783 million people lack access to safe drinking water (United Nations 2012). These statistics likely underestimate the number of people facing chronic resource insecurity; there are, as yet, no agreed-upon methods for estimating global food or water insecurity (Bakker 2012; Barrett 2010).

Systematic Evaluation of Parallel Theoretical Propositions

Our specific procedural approach in this essay is to identify and evaluate well-evidenced theoretical propositions from research on food that might allow us suggest, expand, and enhance parallel theoretical models for water. First, we derive these theoretical propositions from major reviews of historical, ethnographic, and biocultural research on hunger, famine, and food insecurity. Then we test these propositions against the existing water-related evidence. Where possible, we treat food and water insecurity as distinct phenomena, though we make note of the cases (e.g., drought-related famines) in which it difficult to disentangle their effects. We draw our evidence from a wide range of anthropological studies, based on exhaustive literature review; consultation with expert colleagues; and our own research. We used several academic databases to perform the literature review (using keywords such as "water," "drought," "thirst," and "dehydration"). We found the Human Relations Area Files (i.e., documents catalogued under the Outline of Cultural Materials Code 271 for "water and thirst") especially useful for uncovering discussions of water insecurity in the context of broader ethnographies. In table 1, we summarize each theoretical proposition and our analysis of the evidence found to support it.

General Proposition 1: Institutional Theories Best Explain Relative Vulnerability to Resource Insecurity at the Community Level

The food literature provides evidence of five key drivers that explain community-level differences in vulnerability to food insecurity. These are (*a*) ecology, (*b*) population, (*c*) governance, (*d*) markets, and (*e*) entitlements (Butterley and Sheperd 2010; Devereux 1993; Hadley and Crooks 2012). Across these, institutions—that is, the rules and norms that govern resource ownership and distribution (Ostrom 1990)—are arguably the most influential (Sen 1981). Here we describe each of these explanatory models taken from the food literature and then evaluate each of these key drivers against the water evidence.

Ecology

Early theories of famine identified ecological factors, such as climate, as the primary cause of food shortages (Devereux 1993; Walker 1989). Ecological factors—including seasonality, aridity, drought, and climate change—also contribute significantly to community vulnerability to water scarcity. However, it is well accepted that theories of water insecurity must take into account social, cultural, political, and economic factors (Donahue and Johnston 1998); ecology alone is not enough. For instance, migratory movements allow pastoralists and their herds to survive in arid and drought-prone environments (e.g., Dyson-Hudson and McCabe 1985). Conversely, development schemes that limit pastoralists' movement can profoundly undermine their ability to thrive in unpredictable arid climates (Ellis and Swift 1988). In agricultural and urban communities, too, social systems overlay ecological ones and mediate human access to natural resources. In the West Bank, for instance, Hassoun (1998:319) argued that laws governing water rights and access transformed this arid land into a fertile, water-rich environment for Israeli settlers, while it remains a marginal, water-scarce environment for Palestinians. Beyond the challenges posed by seasonality and aridity, climate change is anticipated to worsen water insecurity in some areas of the world (Vörösmarty et al. 2000, 2010). Yet studies in settings as diverse as Brazil (Finan and Nelson 2001) and Burkina Faso (West et al. 2008) demonstrate that communities can adapt to adverse climate changes (i.e., declining rainfall and increasing drought) by redesigning agricultural systems and diversifying livelihood strategies. For both food and water, ecological factors can create stresses or trigger crises, but understanding why some communities weather these challenges successfully while others do not requires analysis of the local institutions that shape resource management and access.

Conclusion: Ecological explanations are necessary but insufficient to predict or explain community-level vulnerability to resource insecurity.

Population

Neo-Malthusians have long argued that overpopulation drives famine and food insecurity (e.g., Ehrlich and Ehrlich 2013; Gilland 2008), though many others have maintained that such explanations are overly simplistic (Butterley and Sheperd 2010; Devereux 1993, 2007; Hadley and Crooks 2012; Walker

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Table 1. Summary of theoretical propositions and evaluation of evidence from the literatures on food and water insecurity

Propositions	Food insecurity evidence	Water insecurity evidence
1. Predictors of insecurity at the community level:		
a. Ecology	Weak	Weak
b. Population	Weak	Weak
c. Governance	Strong	Strong
d. Markets	Strong	Strong[b]
e. Entitlements	Strong	Weak (few cases)[b]
2. Adaptive household responses to insecurity:		
a. Intensification:		
Labor-intensive, lower-yield production	Strong	Strong
Foraging for wild resources	Strong	Strong (historical)[b]
Earning income to buy resources	Strong	Weak (indirect)[b]
Selling assets or borrowing on credit/taking out loans to buy resources	Strong	None[b]
b. Modified consumption:		
Cutting back servings or shares	Strong	Strong
Making substitutions	Strong	Strong (few cases)[b]
Consuming proscribed or stigmatized substances	Strong	Weak (few cases)[b]
c. Migration:		
Fostering out children	Strong[a]	None[b]
Seasonal or temporary migration	Strong[a]	Strong[a]
Resettling the household permanently	Strong[a]	Strong[a]
d. Reprioritization or abandonment:		
Withdrawing from resource-sharing obligations	Strong	Weak (few cases)[b]
Prioritizing certain household members' needs	Strong	Weak (one case)[b]
Abandoning the weakest household members	Strong (few cases)	Weak (two cases)[b]
3. How insecurity affects individual emotional well-being and mental health:		
a. Uncertainty and unpredictability pathway	Strong[a]	Strong[a]
b. Stigma and social failure pathway	Strong	Weak (indirect)[b]
c. Social injustice pathway	Weak (indirect)[b]	Strong (few cases)[b]

Note. Our characterization of evidence as "weak" or "strong" is explained in detail in the text. Put briefly, we consider evidence in support of a proposition to be strong when the phenomenon is clearly documented in numerous cases that span across cultures and time. We have noted exceptions in which we have found strong evidence in historical cases only (limiting our understanding of the phenomenon across time) or in a few very well-documented cases (limiting our understanding of the phenomenon cross-culturally). In contrast, we consider evidence to be weak when we found few or no cases in the literature that support a proposition. When we suspect that a lack of scholarly attention explains the absence of evidence, we have noted either that (1) there are very few cases or the cases discuss the phenomenon only briefly or (2) the existing evidence is indirect (e.g., implies that the relationship exists but does not document it conclusively).

[a] Cases in which it is difficult to disentangle the evidence on food insecurity from the evidence on water insecurity (e.g., drought-related famines).

[b] The archaeological, historical, or ethnographic records we consulted are largely silent on this issue. New studies are needed to definitively evaluate this proposition.

1989). Demographic arguments also figure prominently in contemporary discussions of water scarcity (e.g., Postel 1997). However, as Boberg (2005) explains, population-driven projections of water scarcity tend to overstate and sensationalize water problems; a more sophisticated approach combines demographics with data on governance, technology, adaptability, and other mitigating factors. Simplistic demographic analyses are limited in their ability to predict local water insecurity for several reasons. First, large population centers typically have the economic and political power to build costly water infrastructure and appropriate distant water sources. For instance, Cirelli (2002) demonstrates how Mexico City developed a legal framework and large-scale infrastructure to appropriate water from the Alta Lerma region, creating water insecurity in distant rural communities. Second, as Boserup (1981) argued regarding agriculture, resource stress can create more efficient and innovative management regimes. In China, for example, national policies promote the development and adoption of water-saving agricultural technology to offset growing urban demands for water (Blanke et al. 2007). Third, contrary to the "tragedy of the commons" narrative, there is abundant evidence that communities can sustainably manage water as a commons—even in the face of significant population and ecological pressures (Ostrom 1990). Trawick's research (2003) in Huaynacotas, Peru, demonstrated how institutional rules for making equitable reductions to household

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water allotments during droughts ensured that no sector suffered disproportionate water scarcity. In sum, as Vörösmarty et al. (2000) concluded, population is a major driver of imbalances between water supply and demand, but detailed research on social structure and adaptations (including changes to water provision, delivery, and use) is necessary to predict emerging water vulnerabilities at the local level.

Conclusion: Demographic explanations are necessary but insufficient to predict or explain community-level vulnerability to resource insecurity.

Governance

Government policies can create food insecurity (e.g., agricultural or development policy) or fail to prevent it (e.g., food supplementation) (Butterley and Sheperd 2010; Devereux 1993; Hadley and Crooks 2012; Walker 1989). Since Steward (1949) and Wittfogel (1957), numerous studies have established the value to society of centralized development or public investment in water infrastructure and institutions. There is also good evidence that failed government policies can inadvertently create water insecurity (Bakker 2010). One common trend is that institutions and infrastructure that are initially designed to promote equitable water distribution ultimately become agents of inequity due to poor design, underfunding, corruption, and other problems (Thompson et al. 2001; White et al. 1972). For instance, Boelens's research on Andean irrigation (1998:27) illustrates how ill-planned projects can create water insecurity for those located above canals or at the tail end of distribution cycles. Similarly, Gandy's study (2008) of infrastructural fragmentation in Mumbai, India, demonstrates that, despite planners' efforts to emulate modern models of water management, slums remain excluded from the city water system. Beyond problems associated directly with water policy, other government policies can negatively affect water availability. For instance, industrial development policies can create water insecurity by both overconsuming and polluting local water supplies. On the Hopi Reservation of northeastern Arizona, for example, local groundwater has been depleted and contaminated by the US-subsidized coal mining industry, despite the US government's extensive responsibilities for the oversight of groundwater quality, environmental health, and Indian trust resources (Whiteley and Masayesva 1998). As Bakker (2010) argues, governance failures are complex phenomena—rooted in both flaws of governance structures and the private interests that influence them—deserving of much more scholarly scrutiny. One aspect of flawed governance that particularly deserves more attention is the role of nongovernmental organizations in water management, both in contemporary society (e.g., the World Bank, as in Goldman 2007) and in the archaeological record (e.g., religious associations, as in Haemers and Ryckbosch's study [2010] of medieval Europe).

Conclusion: Government policies are sufficient to predict or explain some, but not all, community-level patterns of vulnerability to resource insecurity.

Markets

Market dynamics (e.g., inflation, speculation, hoarding, price increases or bubbles, market manipulation)—which are considered "failures" by some and "normal" by others—create food insecurity, especially for the poor (Butterley and Sheperd 2010; Devereux 1993; Hadley and Crooks 2012). Unlike food, water historically has been treated as a common-pool or open-access resource in many places. Markets became prominent in global water management only in the last 25 years (Bakker 2010; Strang 2004), though there are historical examples of private sector involvement in water distribution (e.g., Castro 2007; Kazimbaya-Senkwe and Guy 2007; Sawchuk 1996). Privatization reforms can theoretically range from short-term public-private partnerships to full divestiture; in practice, complete privatization of water infrastructure and assets is relatively rare (Bennett 2002). Perhaps due to the diversity of private sector roles in water management (and the difficulty of tracking informal and unregulated markets), the vagaries of water markets are not as well studied as those of food markets. Existing studies do indicate that similarities may exist. In many wealthy countries, governments subsidize or regulate water markets, putting the cost of water within the reach of the poorest citizens (Rogers et al. 2002). When water costs are inadequately subsidized—and the poor must bear the full costs of private water delivery—poverty and water scarcity are tightly linked. For example, Mustafa and Reeder (2009) found that, after privatization reforms in Belize City, water tariffs increased and, when people were unable to pay, disconnection rates skyrocketed; thus a reform designed to improve water delivery in fact created water insecurity for many. Similarly, Johnston (2005) reports that the adoption of "full cost recovery" mechanisms resulted in 10 million impoverished South Africans having their water shut off when they were unable to pay water bills. These findings indicate that approaches used to understand how poverty produces hunger, such as Moser's asset vulnerability framework (1998), may be particularly fruitful for studies of water insecurity (e.g., Mason 2012). Additionally, analyses of institutional design for water privatization (e.g., Goldman 2007), the structure and function of "pro-poor" concessions (e.g., Hall and Lobina 2007), and the ability of the poor to pay the costs of private water delivery (e.g., Castro 2007) have been effective in pinpointing where and how water scarcity has emerged (Laurie 2007).

Conclusion: Market dynamics are sufficient to predict or explain some, but not all, community-level patterns of vulnerability to resource insecurity.

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Entitlements

Sen's entitlement theory (1981) revolutionized theoretical understandings of hunger and famine by shifting the focus of analysis from drought and overpopulation to institutional arrangements (Devereux 1993, 2007). Entitlement theory is focused on determining how people's reliance on the diverse institutions that govern access to food—production, trade, labor, and transfers (e.g., from kin or government)—put them at risk of starvation (Sen 1981). "Entitlements" describe a person's ability to obtain food legally through various institutional channels; "entitlement failure" occurs when, drawing on this diverse set of institutions, a person is unable to obtain enough food to survive. Recently, Anand (2010:188) has argued that the application of entitlement theory to water research—and the related realization that water scarcity is a problem of who gets a resource, not how much of it exists—is long overdue. Other scholars have also emphasized the value of entitlement theory's focus on socioeconomic institutions in explaining how water insecurity arises (e.g., Butterley and Sheperd 2010; Mehta 2006). To date, only a few scholars have explicitly taken an entitlement approach to examining how complex, interlocking institutional arrangements shape water access and insecurity. Chalaune's (2009) analysis of water insecurity in Nepal, for instance, explores how entitlements linked to the state, nongovernmental organizations, local kingship and chieftainship systems, and kinship hierarchies produce water insecurity for some social classes. As this example demonstrates, a particular advantage of this approach is that it can facilitate the analysis of multiple institutions within the same theoretical framework. Beyond the handful of studies that explicitly use entitlement theory, a growing number of studies also employ related approaches (e.g., vulnerability and resilience theory) to understand how the coupled dynamics of socioecological systems produce food or water insecurity (Eakin and Luers 2006; Nelson et al. 2007).

> *Conclusion*: Entitlement failure may be sufficient to predict or explain many community-level patterns of vulnerability to resource insecurity.
>
> *Overall evaluation of proposition 1*: For food and water, ecological and demographic explanations are needed to inform our understanding of resource dynamics, but entitlements (including those derived from governance and market dynamics) are more immediate predictors of insecurity at the community level.

General Proposition 2: Households Respond Adaptively to Resource Insecurity

The household, as a major site of coordination and learning of food-related production and distribution strategies, is a key unit for organizing response to food insecurity (González de la Rocha 2001, 2006, 2007; Netting et al. 1984; Wilk 1989). From the literature on famine and food insecurity, we can identify four potential types of adaptive household-level coping strategies: (*a*) intensification, (*b*) modified consumption, (*c*) migration, and (*d*) reprioritization or abandonment. In each section below, we briefly summarize the findings regarding food in these four domains and then draw on ethnographic accounts to determine the extent to which they seem to apply to water.

Intensification

In this section, we evaluate the evidence that food- and water-insecure households intensify resource acquisition efforts by (1) adopting more labor-intensive but lower-yield production strategies, (2) foraging for wild resources, (3) earning income to buy resources, and (4) selling assets or going into debt to buy resources.

First, food-insecure households adopt more labor-intensive but lower-yield food-production strategies, such as farming less productive land or crops (Butterley and Sheperd 2010; Corbett 1988; Hadley and Crooks 2012; Shipton 1990; Walker 1989). We found many ethnographic and historic cases in which water-insecure households adopted labor-intensive or less-productive technologies to harvest water. In cold-weather climates, for instance, ethnographers document time-consuming and labor-intensive techniques used to collect and melt ice (e.g., Bogoras 1904). In arid environments, ethnographers past and present widely note indigenous peoples' skill in exploiting "hidden" water sources, such as holes dug to capture the baseflow of seemingly dry riverbeds (e.g., Chewings 1936). We conclude that there is abundant evidence that water-insecure households do intensify their efforts, using less-productive strategies to obtain water.

Second, food-insecure households forage for foods that grow wild and are not normally eaten during nonhunger periods (Butterley and Sheperd 2010; Corbett 1988; Hadley and Crooks 2012; Maxwell et al. 2008; Shipton 1990; Walker 1989). Historical and ethnographic records similarly show that water-insecure households increase exploitation of wild plants and animals to stave off dehydration. Historically, people consumed a wide variety of wild plants when thirsty, such as cereus cactus in the American Southwest (Castetter and Underhill 1935), Kurrajong and mallee tree roots in Australia (Chewings 1936), and liana vines in Dominica (Taylor 1938). Additionally, there are historical accounts of harvesting water from animal sources, including from camel paunches in Syria and Saudi Arabia (Musil 1928), antelope rumen in the Kalahari (Silberbauer 1972), and whale intestines and birthwater of alpaca dams in Siberia (Bogoras 1904). Yet, we find little or no indication in contemporary ethnography that these strategies have been sustained as cultural knowledge or practice.

Third, food-insecure households intensify efforts to earn income to buy food, often by expanding the range of household members engaged in wage labor (e.g., sending women and children to work) or by engaging in stigmatized or ex-

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ploitative forms of labor (Corbett 1988; Hadley and Crooks 2012; Moser 1996; Shipton 1990; Walker 1989). In the ethnographic record, there is indirect, but not direct, evidence that households intensify income-generation efforts to buy water. For instance, contemporary studies establish people's willingness to pay (e.g., Whittington et al. 1991) and inability to pay (e.g., Mustafa and Reeder 2009) the cost of water sold as a commodity. Yet, to our knowledge, there is no scholarly literature specifically examining households' efforts to earn income for water purchases.

Fourth, food-insecure households sell household assets or borrow on credit/take out loans to buy food (Butterley and Sheperd 2010; Corbett 1988; Hadley and Crooks 2012; Maxwell et al. 2008; Shipton 1990; Walker 1989). In our literature review, we found no evidence that water-insecure households borrow on credit, take out loans, or conduct distress sales of assets in order to buy water. Because the privatization and commercialization of water is geographically limited and historically recent (Bakker 2010), we believe water-insecure households are more likely to draw on the social systems that have historically mediated access to water, such as kinship (Gluckman 1964), reciprocity (Wutich 2011), and social networks (Goldin 2010). However, it is possible that borrowing on credit or conducting distress sales in order to buy water do occur but have not been documented in the literature.

Conclusion: Food- and water-insecure households adopt less productive and more labor-intensive harvesting strategies, but distress sales of labor/assets and indebtedness are apparently limited to food-insecure households.

Modified Consumption

Here, we evaluate the evidence that food- and water-insecure households modify consumption by: (1) cutting back servings or shares, (2) making substitutions, and (3) consuming proscribed or stigmatized substances.

First, food-insecure households cut back the size of food portions or the number of meals to make less food last longer (Corbett 1988; Hadley and Crooks 2012; Maxwell et al. 2008; Moser 1996; Shipton 1990). The historic and ethnographic literature indicates that water-insecure households use a range of techniques to modify their water consumption. Initially, they cut back on water-intensive cleaning tasks (Chewings 1936; Eichelberger 2010; Gleick 1996; Hadley and Wutich 2009; Silberbauer 1981). When drinking water is scarce, people delay dehydration onset by "priming the body" or drinking large amounts less frequently (Adolph 1947; Marshall 1976). When drinking water is absent, people use plants to help suppress thirst, such as sorrel leaves in East Africa (Merker 1910), pine gum in the American Southwest (Cushing 1920), tobacco in the Chuuk (Truk) Islands (Bollig 1927), and coca in the Andes (Stair 1897). We conclude there is strong evidence that people in water-insecure households also cut back on water consumption during periods of scarcity.

Second, food-insecure households substitute cheaper, less nutritious foods for more expensive, calorie- or vitamin-rich foods (Corbett 1988; Hadley and Crooks 2012; Maxwell et al. 2008; Moser 1996; Shipton 1990). In a few historical ethnographic cases, there is very clear documentation of the widespread substitution of other substances for drinking water. For instance, green coconuts were historically a principal source of hydration in water-scarce (e.g., atoll-based) Micronesian and Polynesian societies (e.g, Montes de Oca 1893; Spiro 1949; Thompson 1940). For weeks or months, melons were substituted for water among the G/wi (Silberbauer 1972), !Kung (Marshall 1976), and Teda (Chapelle 1957). More recently, there is some evidence of substitution of prepackaged and sweetened beverages for drinking water, particularly among the urban poor in sub-Saharan Africa, which may be due in part to concerns over water contamination (Wojcicki and Heyman 2010). Additionally, there are some examples of the substitution of gray water (i.e., previously used water) for household tasks—but not consumption—when clean water is scarce (e.g., Wutich et al. 2014). While the number of cases we uncovered is somewhat limited, we find strong evidence that substitutions for clean water do occur cross-culturally.

Third, food-insecure households eat stigmatized or proscribed foods, sometimes called "famine foods," when preferred foods are unavailable (Butterley and Sheperd 2010; Corbett 1988; Hadley and Crooks 2012; Maxwell et al. 2008; Shipton 1990). Cross-culturally, seawater and urine appear to be the only liquids that may carry proscriptions against drinking (e.g., Bollig 1927), likely because they carry risks of dehydration, infection, or kidney failure. Documented violations of these prohibitions exist, typically during shipwrecks (e.g., Riley 1817) or seafaring (e.g., Stair 1897). Because reporting on this issue is scarce, these practices may be more extensive than historic and ethnographic records seem to indicate. Beyond seawater and urine, there is little historic evidence of stigmatization of water sources unless disease was suspected (e.g., Chapelle 1957; Cipriani 1961). In contrast, an enormous range of water colors, tastes, smells, and sources have become stigmatized in contemporary society—only some of which can be explained by public perceptions of disease etiology (Dietrich 2006); the poor routinely resort to drinking such stigmatized water (e.g., Auyero and Swistun 2009). As yet, however, there is no literature that specifically documents or explores the practice of drinking stigmatized liquids during periods of water scarcity.

Conclusion: Food- and water-insecure households cut back on intake, make substitutions, and ingest proscribed or stigmatized substances.

Migration

In this section, we evaluate the evidence that food- and water-insecure households enhance members' access to resources

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by (1) fostering out children, (2) seasonal or temporary migration, (3) resettling the household permanently.

First, food-insecure households, particularly those in areas affected by famine, may foster their children out to relatives who live outside of the famine zone and who can better ensure the children's nutrition well-being (Hadley and Crooks 2012; Shipton 1990; Walker 1989). In our review, we found no evidence that the decision to foster out children is directly related to water insecurity or scarcity, even in the context of severe drought; rather, such decisions are depicted as a response to food insecurity (e.g., Fleurett 1986; McCabe 1990). However, it is also possible that water insecurity does actuate child fostering (or that water insecurity also plays a role in the decision making of households depicted as "food insecure"), but this has not yet been documented.

Second, members of food-insecure households migrate seasonally or temporarily to improve livelihood security or wage earnings and may send remittances back to the household of origin (Butterley and Sheperd 2010; Corbett 1988; Dirks 1980; Hadley and Crooks 2012; Shipton 1990; Walker 1989). The ethnographic record clearly demonstrates that, when water scarcity undermines livelihoods, adult household members—or even the entire household—may migrate. Such migrations may occur temporarily either as part of customary seasonal migration patterns or in response to unanticipated drought or desertification. For instance, pastoralists typically migrate seasonally in search of water and forage (e.g., Dyson-Hudson and McCabe 1985); at times, severe droughts may require pastoralists to relocate entire households temporarily (e.g., McCabe 1990). In agricultural settings, drought-struck households send able-bodied adult members to engage in wage labor and send remittances to remaining household members (Banerjee et al. 2011). It is important to note that food and water insecurity co-occur in most of these cases, and it is difficult to determine the relative role each factor plays in the decision to migrate.

Third, when food-insecure households lose the ability to maintain their livelihoods, they may resettle the household permanently in a new region (Butterley and Sheperd 2010; Corbett 1988; Dirks 1980; Hadley and Crooks 2012; Shipton 1990; Walker 1989). There is abundant archaeological and historical evidence that drought and desertification produce large-scale, permanent migration (Spielmann et al. 2011). In the archaeological record, examples include the Maya (Lucero 2002), Tiwanaku (Ortloff and Kolata 1993), and Mimbres (Spielmann et al. 2011). In the recent historical record, well-documented agricultural cases include droughts in the United States (Gutmann et al. 2005), Canada (Gilbert and McLeman 2010), and Mali (Findley 1994). To date, we know little about how various forms of water insecurity might shape migration among urban households.

Conclusion: Food- and water-insecure households engage in short-term migration and long-term resettlement, but apparently fostering out children is used as a response only to food insecurity.

Reprioritization or Abandonment

Here, we evaluate the evidence that food- and water-insecure households reprioritize the needs of members by (1) withdrawing from resource-sharing obligations to nonhousehold members, (2) prioritizing some household members' needs over others, and (3) abandoning the weakest household members.

First, food-insecure households withdraw from food-sharing obligations when resources become too scarce to support dependents beyond the household (Corbett 1988; Dirks 1980; Moser 1996; Shipton 1990; Walker 1989). Compared with the food literature, there are very few studies establishing the existence of social norms for water sharing, reciprocity, or charity in water-scarce environments (but see norms documented among the Navajo in Roberts 1951; Nuer in Gluckman 1964; Moroccan Berbers in Blanco Izaga and Hart 1975; Bolivians in Wutich 2011; and Alaskans in Eichelberger 2010). That said, some limited evidence indicates households in extremely water-scarce environments do refuse requests for water from outsiders (Musil 1928), other members of their own community (Sekaquaptewa and Udall 1969), and even members of their extended family (Jewell and Wutich 2011). However, more research is needed to definitively evaluate this proposition.

Second, food-insecure households may allocate larger food portions to some household members (Dirks 1980; Walker 1989), such as nutritionally vulnerable children (Hadley and Crooks 2012; Maxwell et al. 2008) or income-generating men (Butterley and Sheperd 2010; Corbett 1988). In our literature review, we found only one ethnographic account in which some household members were given preferential water allocations. When the San experience water shortages, according to Silberbauer (1981:221), "A person's needs determine how much of the household ration each is given; children receive larger rations because their water requirements are considered greater than those of adults. Pregnant women and nursing mothers are also accorded larger shares." While the reprioritization of household water use tasks has been well documented, almost nobody has examined intrahousehold reprioritization of drinking water needs.

Third, in extreme cases of famine, stronger household members (e.g., adults) may abandon more vulnerable household members (e.g., children, elders, or pregnant women) in a last-ditch effort to obtain enough food to survive (Butterley and Sheperd 2010; Dirks 1980; Shipton 1990). In the ethnographic record, there are indications that abandonment of vulnerable family members also occurs in extremely water-scarce conditions (e.g., Turnbull 1972). For instance, Lebzelter (1934:16) describes how, under threat of "death from thirst," the San "are forced to leave the old and the sick behind in

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the wilderness." Though not uncommon, Lebzelter argues that such losses are not normalized but rather are experienced by the San as a tragedy. These few ethnographic accounts suggest that households may reprioritize or abandon members under water-scarce conditions, but much more research is needed to confirm this and determine how reprioritization and reorganization are patterned cross-culturally.

> *Conclusion*: The evidence that households withdraw from sharing arrangements, reprioritize members' needs, and abandon weak members is much stronger for food than for water insecurity.

> *Overall evaluation of proposition 2*: The historic, ethnographic, and biocultural evidence indicate that households respond in similar ways to food and water insecurity, but the range of documented strategic household responses to water insecurity is narrower.

General Proposition 3: Resource Insecurity Promulgates Emotional Distress and Mental Ill-Health in Individuals

Food insecurity is well-established as a trigger for rising levels of emotional distress and mental ill health, especially anxiety and depression (Hadley and Crooks 2012; Lund et al. 2010). Weaver and Hadley (2009) propose that there are multiple possible pathways that explain this, including (*a*) uncertainty and unpredictability and (*b*) social stigma and shame. Additionally, some work on moral economies and hunger suggest (*c*) perceptions of unfairness or injustice provoke emotional distress (e.g., Messer 2009; Orlove 1997; Scott 1977). Here we briefly explain each hypothesized pathway, and then examine the evidence relevant to evaluating that hypothesis in the water realm.

Uncertainty and Unpredictability

Food insecurity creates uncertainty and unpredictability, which leads to stress, which creates anxiety and depression (Hadley and Crooks 2012; Weaver and Hadley 2009). The clearest evidence linking water insecurity, uncertainty/unpredictability, and mental health outcomes comes from studies of drought. Since the 1970s, numerous studies have documented the negative emotional effects of drought (e.g., Cawte 1978; Pike 2004; Turnbull 1972). For instance, Australians affected by protracted drought, particularly farmers, were at risk for psychological distress, declining mental health, and suicide (Sartore et al. 2008). Uncertainty and loss of control are clearly linked to mental ill health in these drought-affected populations (McCann et al. 2011; Sartore et al. 2008). Because drought research is typically conducted in agricultural settings, however, it is difficult to parse the relative contribution of food and water insecurity to mental health outcomes. Studies conducted in settings where water and food acquisition are decoupled—including slums in India (Siddiqui and Pandey 2003) and squatter settlements in Mexico (Rios et al. 2003)—indicate that water insecurity alone may contribute to emotional distress or mental illness.

To explore how uncertainty or unpredictability affects mental health in resource-scarce contexts, a few studies have examined water and food. For instance, Roberts et al. (2008) found Ugandan refugees who had experienced "lack of food or water" were more likely to suffer depression and post-traumatic stress disorder. Similarly, Coêlho et al. (2004) found drought-affected Brazilians reported elevated anxiety and emotional distress, and suggest that uncertainty and unpredictability around both water and food availability were key stressors. Among the ethnographic studies that examine both water and food insecurity, there are indications that water may be a greater stressor than food (e.g., Mehta 2005:181; Scheper-Hughes 1992:69). For example, ethnographic reports from settings as diverse as the !Kung (Marshall 1976) and Hopi (Talayesva and Simmons 1942) indicate that, when facing water and food insecurity, people chose to increase the certainty or predictability of their water access—even at the cost of food access. One reason for this may be that the risk of death from dehydration is much more immediate than from starvation. The only direct test of this question to date, a biocultural study of Ethiopian women by Stevenson and colleagues (2012), found that water scarcity was a more stable and significant predictor of psychosocial distress than food insecurity.

> *Conclusion*: Food and water insecurity create uncertainty and unpredictability, which can lead individuals to experience emotional distress and mental illness.

Stigma and Social Failure

Food insecurity is a marker of social failure and is associated with socially stigmatized eating and food acquisition behaviors, which lead to feelings of shame, self-blame, stress, anxiety, and depression (Oths and Dressler 2012; Weaver and Hadley 2009). While early ethnographies document flexible hygienic norms that accommodate limited water availability in water-scarce environments (e.g., Chapelle 1957; Chewings 1936; Marshall 1976; Silberbauer 1981), water access in contemporary contexts typically varies greatly between the haves and the have-nots (Donahue and Johnston 1998; Whiteford and Whiteford 2005). In such cases, water insecurity and poor hygiene may become markers of social failure, leading to emotional distress and mental illness. Here we explore the evidence supporting this hypothesis in two realms: research on hygiene and disease, and on gender and hygiene.

First, there is ample evidence that water insecurity, poor hygiene, and waterborne disease produce shame and social stigma. For instance, Curtis and colleagues (2009) found that unwashed bodies are associated with disgust, shame, and social exclusion in sites as varied as Peru, Madagascar, and Vietnam. The link between poor hygiene and shame is so

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widely recognized that it has become the basis for "shaming interventions" to promote sanitation projects (e.g., Pattanayak et al. 2009). Further, when water insecurity results in waterborne disease, the sickness can carry profound social stigma because it is seen as an indicator of poverty, filth, and contamination (e.g., Nations and Monte 1996). Thus, the evidence indicates that—in contexts of social or economic inequality—water insecurity, culturally defined perceptions of "uncleanliness," and waterborne disease become social markers to which disgrace, stigma, and shame are attached.

Second, women's domestic responsibilities put them at disproportionate risk for suffering stigma related to water insecurity (UNDP 2006). For instance, women—and mothers in particular—are more likely than men to be blamed and shamed when homes or children fail to meet cultural standards of cleanliness, washing, or water use (e.g., Reddy and Snehalatha 2011). Further, gendered social standards for physical attractiveness tend to place disproportionate hygienic burdens (e.g., bathing, hair washing) on women and girls (UNDP 2006). When women are unable to obtain sufficient water for menstrual ablutions or hygiene (e.g., cleaning menstrual cloths), they may suffer extreme stigma and humiliation (Rashid and Michaud 2000:54).

These streams of research provide abundant evidence linking water insecurity, poor hygiene, social stigma, and negative emotions (such as shame) in some cultural contexts. Further research would be needed to prove that water-related stigma can produce mental ill health. If so, the shame associated with poor hygiene may partially explain why the association between poverty and mental ill health is so much stronger for women than men (Patel and Kleinman 2003).

Conclusion: Food and water insecurity are both markers of social failure and produce feelings of shame. While the links between insecurity, shame, and anxiety/depression at the individual level are well evidenced for food, they remain speculative in research on water.

Social Injustice

Studies of food riots and moral economies of food suggest that people experience anger, outrage, and other forms of emotional distress when they feel that social injustices produce food shortages or price hikes (e.g., Messer 2009; Orlove 1997; Scott 1977; Spielmann et al. 2009). Recent research indicates that perceived inequity or injustice in water institutions may be a major driver of emotional distress.

Several studies have shown how inequity or perceived injustice in the design of water institutions produces emotional distress (e.g., Sultana 2011). For instance, Goldin (2010) explored how social and political exclusion in the water sector produce one negative emotion: shame. Based on long-term research in South Africa, Goldin demonstrated how social divisions established during apartheid produced inequities in access to and control of water. Long after the end of apartheid, the exclusion of black water users from water management, knowledge, and power evoke profound feelings of shame. Ennis-McMillan (2006), in his ethnography of a water-scarce Mexican town, was the first to theorize that social inequality produces "suffering from water," a term used colloquially to describe frustration, anguish, bother, worry, and anger over water scarcity (117). While concern about water scarcity was widespread, Ennis-McMillan argues that only people in the lower and middle classes—who depended on an overstressed community water system (rather than privately owned tanks) for water—shared the collective experience of suffering from water. Following Ennis-McMillan's social inequality hypothesis, Wutich and Ragsdale (2008), in research with squatters in Cochabamba, Bolivia, examined how water availability, economic and social assets, and institutional entitlements to water affect experiences of emotional distress (i.e., fear, worry, anger and annoyance). They found that water availability (i.e., the amount of water people used) was not significantly associated with emotional distress. Rather, emotional distress was associated with decreased economic and social assets and, unexpectedly, increased use of certain water institutions (i.e., markets and reciprocal exchanges) but not others (i.e., self-governed common-pool resources). Wutich and Ragsdale propose, based on these results, that suffering associated with water insecurity could develop as a by-product of the stressful negotiations required to gain access to water institutions that lack culturally appropriate rules, procedures, and rights.

Together, these studies suggest that social suffering and emotional distress over resource insecurity may be rooted in experiences of institutional injustice.

Conclusion: Perceived social injustices in food and water institutions can produce severe emotional distress in individuals; it is unknown whether these experiences of institutional injustice also produce mental ill health.

Overall evaluation of proposition 3: Both food and water insecurity appear to cause emotional distress and mental ill health in individuals; while water may be a more severe stressor, distress related to food appears to be more common.

Discussion: Theoretical Parallels, Distinctions, and Puzzles

Based on the analysis of ethnographic, historical, and biocultural data provided above, we can now articulate a number of important ways in which food and water insecurity are similar, allowing theories of food to inform our understanding of water. Yet, there are several key differences, and these distinctions clarify how and when food- and water-related theories should not be assumed to be consonant with each other. To discuss these similarities and distinctions, and their implications for identifying important avenues for future research, we return briefly to the questions we laid out at the

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Table 2. Potential areas for future research on food and water insecurity

Levels of analysis	Examples of specific questions for future research
Conceptual	What cultural norms, if any, exist for water consumption and sharing?
	Are cultural norms for food more common or developed, historically and currently, than for water?
	In what contexts have certain forms of water quality, acquisition, or consumption become stigmatized?
	Is the stigmatization of food insecurity more severe or common than the stigmatization of water insecurity?
Community	What forms of governance produce both food and water insecurity?
	For instance, under what conditions do specific policies (e.g., marketization) create community-level vulnerabilities to food and water insecurity?
	In privatized water systems, do markets produce water insecurity in the same way that they produce food insecurity? For instance, does inflation, speculation, hoarding, or market manipulation play a role in creating water insecurity, as in creating food insecurity, for impoverished communities?
	What is the role of nongovernmental organizations in producing or buffering against food and water insecurity?
	How do complex, interlocking institutional arrangements produce food and water insecurity? Are there certain configurations of resource institutions that are more likely to produce food insecurity, water insecurity, or both?
Household	Are water-insecure households less likely to intensify efforts to generate resources through markets (e.g., intensify wage labor, sell assets, take loans) than food-insecure households?
	Are water-insecure households more likely than water-secure households to consume water from stigmatized sources or water of stigmatized quality?
	Are decisions to foster children, migrate temporarily, or resettle permanently during droughts more related to food insecurity, water insecurity, or both?
	Are water-insecure households less likely to reprioritize their dependents' needs (e.g., limiting reciprocity, protecting vulnerable members, abandoning weak members) than food-insecure households?
	As water privatization and commodification become widespread, are household-level coping strategies for water insecurity coming to resemble more closely household-level coping strategies for food insecurity?
Individual	Is the elevated risk for mental illness (e.g., anxiety, depression, suicide) associated with drought more related to uncertainty around food insecurity, water insecurity, or some other factor (e.g., livelihood loss)?
	Do feelings of shame and social failure put water-insecure individuals at greater risk of emotional distress and mental ill health? If so, how does this process compare to that experienced by food-insecure individuals?
	Is perceived injustice or unfairness a risk factor for emotional distress and mental ill health for both food-insecure and water-insecure individuals? If so, what forms of injustice or unfairness are most distressing?

start of this essay. In table 2, we identify potential areas for future research on food and water insecurity.

Are food and water insecurity truly parallel phenomena? We have shown that experiences of food and water insecurity are similar enough to facilitate a broader theory of resource insecurity. Yet there are some crucial differences between these phenomena that should be acknowledged in any analysis that compares them. First, the health impacts of dehydration and starvation differ. While dehydration poses a more immediate threat (typically, death in days rather than weeks), malnutrition is more likely to have lasting effects on growth and development. Second, cultural norms for food appear to be more common and developed than for water. In the food realm, there is abundant historic and ethnographic literature establishing the existence of socially valued foods, culturally acceptable ways of accessing food, and cultural norms for food sharing. The historic and ethnographic literature on water is largely silent on these issues, with only a handful of exceptions. Third, water insecurity may be more immediately visible (e.g., violation of hygiene norms) than food insecurity (e.g., visible malnutrition or consumption of famine foods) and thus may be quicker to evoke social stigma. However, the literature indicates that the stigmatization of food insecurity may be much more severe and common cross-culturally than stigmatization of water insecurity (though the lack of research on water and stigma makes it hard to draw clear conclusions on this point). These differences may have important implications for the pathways by which food and water produce household and individual impacts; we believe these questions offer fruitful paths of inquiry for further research.

What are the most powerful drivers shaping community vul-

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nerabilities to resource insecurity? We have identified several factors—including ecology, population, governance, and markets—as important drivers of food and water insecurity. However, there are some important points of differentiation. One key difference is related to theories of governance. Governance failures in the food sector appear to be primarily at the level of protections: market interventions (e.g., subsidies) and "safety nets" (e.g., supplementation systems). In the water sector, the role of the state in managing water is greater, and so its failures—in planning, infrastructure provision and maintenance, and environmental regulation—appear to be more fundamental to the emergence of inequity and vulnerability than in the food sector. A second key difference is related to the role of markets in producing resource insecurity. Food systems are easily and often fully privatized, and consequently markets figure prominently in theories of famine and food insecurity. In contrast, water systems are not easy to privatize and privatization undermines significant public benefits; therefore complex public-private partnerships are more common than full privatization. Caution is needed in directly applying theories of food markets to research on water markets, and independent theories of the market dynamics that produce water scarcity and insecurity may be needed. Despite these differences, we see great potential for bringing both phenomena into one analytic framework. There is a nascent movement arguing in favor of adapting and applying entitlement theory, which was originally devised to explain famines, to water issues. We agree with Anand (2010) that this approach holds promise for advancing theories of water insecurity, and we further suggest that it may have as-yet-unexplored potential for building a unified theory of resource insecurity (see Devereux 2007:66–84 for a detailed discussion of cases in which entitlement theory can and cannot be applied).

What household-level strategies appear to be most effective at coping with resource insecurity? Our analysis uncovers many similarities in household-level coping strategies. The clearest example is the suite of techniques used to modify and reduce household consumption of highly valued sources of food and water. Another example is in the tendency of drought-affected households to migrate, whether partially, temporarily, or permanently. Yet in many of the cases we found—particularly in agricultural settings—it is unclear to what extent food versus water shortages ultimately drive the decision to migrate. Research that seeks more explicitly to disentangle household experiences of food and water insecurity could help to clarify these questions. Despite these similarities, food-insecure households appear to have developed a greater variety of coping strategies than water-insecure households. For instance, food-insecure households typically intensify their efforts to procure food from both market and nonmarket sources; yet, water-insecure households largely appear to restrict their intensification efforts to nonmarket sources. Similarly, the reprioritization of household members' needs appears to be much rarer in water-insecure than food-insecure households. In both cases, we strongly suspect that these findings may be artifacts of the poor documentation of intrahousehold dynamics in water-scarce environments; more research is needed to determine definitively if these coping strategies are not used in water-insecure households. Additionally, we hypothesize that as a result of recent and major historical shifts in how people gain entitlements to water—particularly, the large-scale privatization and commodification of water—household coping strategies for water insecurity will begin to more closely resemble those long used to cope with food insecurity.

What are the biocultural costs of the coping process for individuals—that is, what happens when individuals are pushed beyond their capacity to respond effectively to resource insecurity? Research on the biocultural costs of coping with resource insecurity is at an early stage, but we can identify some important apparent parallels and distinctions between food and water studies. First, uncertainty or unpredictability as a cause of emotional distress or mental illness seems to work similarly for food and water insecurity. Yet, the preponderance of evidence for both comes from studies of drought, which produces food and water insecurity simultaneously. Future studies of food and water insecurity—particularly those conducted in agricultural settings—should be carefully designed to ensure that they can parse the relative impacts of water and food insecurity. Second, there is good evidence that food and water insecurity cause social shaming and feelings of social failure. Further, women seem to be more severely affected than men. Yet differences in the social meaning of food and water insecurity—including inequities in resource availability, the visibility of insecurity written on the body and in the home, and the severity of social stigma around visible insecurity—may mean that these pathways are not fully parallel; this question can only be answered with more comparative research. Third, perceived social injustice appears to play a larger role in distress over water insecurity than food. While early literature on food riots documents anger and outrage over food shortages, the recent literature on water and injustice is beginning to develop a more sophisticated theoretical understanding of how perceptions of institutional injustice put people at greater risk of emotional distress (and possibly mental ill health). In both cases, however, insecure access to food or water may be less stressful than perceived unfairness in how limited resources are allocated.

Conclusion: Toward a Broader Anthropology of Resource Insecurity

In this essay, our goal has been to highlight the potential for advancing a unified theory of resource insecurity—spanning both food and water as basic resources necessary for human survival—and to identify some theoretical puzzles and specific research questions that might move such a field forward. In this final section, we turn to the question of how such an endeavor might contribute to current theoretical and applied interests in anthropology. Broadly, we address several cross-

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subdisciplinary areas of research: critical medical anthropology, economic and ecological anthropology, and biocultural anthropology.

First, following critical medical anthropologists such as Singer (1990) and Farmer (2004), there has been enormous interest in understanding how social structure and structural violence produce disparities in health and well-being. This area of scholarship has great potential for moving forward our understanding of how macrolevel institutional, political, and economic trends produce resource scarcity (and related human health costs) on the ground. Critical medical anthropologists have produced rich ethnographic explorations of how power, inequity, and social exclusion produce hunger. For instance, *Death without Weeping* (1992), Scheper-Hughes's ethnography of child mortality in Brazil, demonstrates how changes in the sugarcane industry—and related labor and land tenure institutions—put displaced laborers' families at much greater risk of suffering hunger. In the water realm, volumes edited by Donahue and Johnston (1998) and Whiteford and Whiteford (2005) demonstrate the potential for a similar analytic approach in research on water. In future research, there is a particular need for more ethnographies of water insecurity written from a critical perspective, such as Ennis-McMillan's *A Precious Liquid: Drinking Water and Culture in the Valley of Mexico* (2006). As thirst, water shortages, and water quality are all understudied from historical and ethnographic perspectives, more research in this vein would add valuable insight to the strong and growing anthropological literature that critically investigates the causes and human health impacts of resource insecurity.

Second, economic and ecological anthropologists have long excelled in institutional analyses of a range of resource problems (e.g., Acheson 2006; Ensminger 1992; McCay 1998; Tucker 2008). Such research often examines how institutional rules or norms produce patterns of resource distribution. Regarding food, for example, Pottier (1999) considered how rural institutions such as land ownership, labor organization, and food markets produce food insecurity in Africa and Asia. Regarding water, Johnston and colleagues (2012) explored how a range of specific institutional arrangements shape water security around the world. Following Anand (2010), we have suggested that Sen's (1981) entitlement theory might push these areas of research forward by offering a unified theoretical framework for exploring similarities and differences in how institutions shape food and water insecurity. Yet, as our review shows, few anthropologists have merged food and water into the same institutional analysis: Nash's (1994) research on subsistence insecurity in three populations (Mayan farmers, Bolivian tin miners, and American factory workers) is a rare exception. She suggests that large-scale institutional transformations, such as the shift from industrial to finance capital in the global economy, undermined subsistence security in a range of economic systems. For anthropologists interested in pursuing research that bridges food and water insecurity, the environmental entitlements approach (Leach et al. 1999)—which expands on Sen's entitlement theory and addresses resource institutions more broadly—offers a way to proceed. As people facing poverty or marginalization often endure food and water insecurity and a range of other insecurities (e.g., land, energy, housing) simultaneously (Perrone and Hornberger 2013), this is a particularly fruitful direction for exploring such clustering of resource insecurities.

Another important articulation with this expanded theory of resource insecurity is the impacts of these types of injustices on human biology and adaptation. Following Leatherman and Goodman (1997), others, including Dressler et al. (2005), McDade (2009), and Gravlee (2009), have advanced a critical biocultural research agenda, examining how social inequalities become embodied in growth, development, immune function, cardiovascular physiology, and other negative biological outcomes. This approach has yielded important insights about the biological contexts of poverty, including how they relate to food insecurity, as seen in the work of Dufour (2006), Hadley and Patil (2006), and Crooks (1999). Yet, beyond the handful of studies examining water and distress (e.g., Stevenson et al. 2012; Wutich and Ragsdale 2008), there is no comparable body of biocultural studies examining the biological effects of new forms of extreme water scarcity, such as under conditions of urban poverty. To provide just one possible example of how this could be advanced, anthropological studies of pregnancy and lactation (e.g., Piperata 2008; Vitzthum and Aguayo 1998) have not yet addressed the effects of poverty-related chronic maternal dehydration on pregnancy, lactation, and child growth and development (cf. Ross and Desai 2005). Beyond the need for biocultural research focused on water specifically, there is a need for more research that examines the iterative biocultural effects of food and water insecurity combined, since they often co-occur.

Research on resource insecurity has great potential for informing ongoing debates around how to deal with expected shortfalls of food and water in the face of climate change, population growth, globalization, and political uncertainty (Johnston and Fiske 2013). The ability to identify powerful drivers of food and water insecurity may assist in joining largely bifurcated efforts to address each problem. Additionally, the ability to recognize "early warning signals" of thirst and hunger may assist in early intervention and relief efforts. Finally, while there has been some debate about the ethics of research on human adaptability (e.g., Singer 1989; Wiley 1992), biocultural research on the biological costs of poverty and inequity can have a powerful and positive effect in the policy realm (e.g., Schell and Tarbell 1998). More of this kind of work has the potential to reveal new approaches to understanding, preventing, and ameliorating the human suffering that comes from resource insecurity.

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Comments

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In a political climate where the usefulness of anthropology is being called into question by policy makers, it is especially critical that anthropologists make the case for how the discipline can address wide-ranging policy issues such as resource insecurity. Wutich and Brewer's piece is a timely contribution to this topic. They have done an excellent job articulating wide-ranging literatures on food security and water scarcity in a manner that is accessible across subfields and beyond anthropology. I have three concerns with this piece, most of which relate to the (understandable) lack of data on a broader resource insecurity anthropology and which may be fruitful avenues of future research.

The first issue concerns the interrelatedness of food insecurity and water scarcity and the degree to which this might impact the patterns the authors are seeing. Wutich and Brewer's piece uses the food security literature as a springboard by which to build an anthropology of resource scarcity, specifically by testing its applicability to the scarcity of another important resource: water. The major difficulty here, which the authors mention but might have emphasized more, is that food and water insecurity often co-occur, so many of the causes and impacts of such insecurities and strategies used to cope with them are not mutually exclusive. Clearly, one of the benefits of an anthropology of resource insecurity would be to disentangle which factors are unique to or similar between water versus food scarcity by viewing them together in a holistic way. However, it may be premature to talk about how water and food scarcities differ, particularly when so little is revealed in the text about the individual historical, cultural, and economic contexts of the studies cited. This lack of context is of course the difficulty in writing a general-level article. In some ways, this paper is a good existing survey of what kinds of linkages anthropologists have not examined rather than firm evidence of cross-cultural generalities.

Second, following Amartya Sen (1981), the authors assign lack of entitlements a central causal role in creating both food and water scarcities over other possible explanations (markets, climate change, etc.). Hopefully this will reinvigorate interest in the anthropological study of entitlements as well as critiques of the concept itself. However, given the strong link between of lack of access to resources (i.e., entitlements) and poverty, to what degree is an anthropology of resource insecurity actually an anthropology of poverty? What would an anthropology of resource insecurity more firmly grounded in poverty studies look like? How might a framing in poverty studies alter the author's conclusions? One of the many challenges of an anthropology of resource insecurity will be in developing a theoretical orientation that manages to bridge the interdisciplinary nature of the topic.

Third, as an archaeologist, I was pleased to see the authors highlight how archaeology's long-term perspective on resource use (and overuse) might benefit a broader anthropology of resource insecurity. As with other anthropological subfields, there has been a growing call to build "usable pasts" (Lane 2011) or a "useful archaeology" (Dawdy 2009), and investigating resource use histories is a critical part of this movement. There is considerable potential for a broader historical anthropology of resource insecurity that documents the trajectories through which modern patterns of scarcity arose on both local and global scales (see Davis 2001). Such historical studies may even help narrow in on early warning signs that indicate future resource insecurity.

In sum, Wutich and Brewis aptly illustrate the need for an interdisciplinary, cross-subfield, and holistic study of resource insecurity. While some of the generalities they draw may be hard to fully evaluate in the limited space they have available, they have outlined numerous avenues for future research that demonstrate the value of an anthropological approach in a world where resources seem increasingly scarce.

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According to Omran's (1971) once popular model of epidemiologic transition, the main threats to health for people in low-income countries were infectious diseases, while people in high-income countries faced noninfectious diseases such as heart disease, diabetes, and cancer. Economic development, the model predicted, would significantly alter the ecologies of poor countries and bring them through an "epidemiological transition" in which the burden of infectious diseases abates along with a rise in the burden of noninfectious diseases. The important ecological changes in poor counties envisioned in Omran's model centered on health systems and public health infrastructure, particularly municipal water systems, modern sanitation, sufficient food production and health care delivery mechanisms (Farmer et al. 2013:320). Until such fundamental changes to the ecologies of poor nations, people in them would die of infectious diseases and "escape" the scourges of noninfectious ones. This model has, of course, been critiqued, largely on the basis of the now well-known dual burden of infectious and noninfectious diseases that plague people in poor countries (Armelagos et al. 2005; Barrett et al. 1998). One of the important lessons that becomes clear in Wutich and Brewis's excellent paper is that poor or nonexistent water systems can be empirically connected not only to multiple infectious diseases, as is well known, but also

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to psychological stress, one particularly burdensome noninfectious global health problem.

We are very supportive of the paper's efforts to clarify what we know and what we do not about the political and social determinants and outcomes of water insecurity and of its call for ethnographic research to fill in the gaps. In our commentary, we raise a couple concerns with conceptual framing and potentially complementary lines of scholarship in which anthropologists and others might play an important role.

First, the paper calls attention to the social production of water insecurity–related distress yet may reinforce a narrow focus on individual- and household-level impacts, particularly emotional distress and mental ill health. Future research, we believe, would do well to focus on individual-level impacts and household-level coping, as well as on social organization and activism beyond the household. The importance of water riots and food riots, after all, include but extend beyond their links to individual- and household-level emotional distress. Socioemotional experiences of shame, anxiety, and mental illness are of course worthy of careful study. But what about anger and outrage, which are mentioned only in passing the paper? Arguably, future ethnographic research on the individual and household dynamics of food insecurity should be complemented by careful examination of suprahousehold water "riots" and forms of activism, and their social, political, and ecological impacts.

Relatedly, we ask whether—and in what ways—ethnographies of water surplus and wastage could complement ethnographies of water insecurity. What might such ethnographic investigation tell us about the social and emotional dynamics of water access and use, and might such work be useful in advocating for broad change in the distribution of water? For instance, could and should interventions aimed at the problem of water wastage in settings of water abundance—and ethnographic evaluation of such interventions—complement the "shaming interventions" cited by Wutich and Brewis, which focus on marginalized people whose hygienic and water use practices do not conform to those of people living in more affluent ecologies?

Second, we suggest that this paper raises an important opportunity to integrate knowledge of water insecurity with recent advances in the field of global health delivery. In addition to ethnographies of structural violence and water insecurity, there is arguably a big need for rigorous mixed-method study and dissemination of what is working in reducing water insecurity along with other health problems, through the implementation of water and health delivery systems at scale.

In other words, can we envision a "science of global water delivery" along the lines of the Global Health Delivery Project at Harvard University?[1] At this writing, that project has not produced a case study of clean water delivery at national or even district-level scales. This is despite the fundamental and widely acknowledged link between water access, health systems, and population health. Access to "an adequate supply of safe water and basic sanitation" was a key part of the definition of Primary Health Care set out in the Alma Ata declaration of 1978. As Jim Kim and colleagues (2013:194) argue, "no health system can provide high-quality care to all those who need it—over the long term—without modern infrastructure, a robust workforce, a decent school system, water and sanitation systems, and a working economy." Meanwhile, the commodification of water and sanitation has been part of a broader commodification of health care in the 1980s and 1990s (World Bank 1993:12; see Basilico et al. 2013).

The lack of a mature science of global water delivery is also surprising given that the world met the MDG target, 5 years ahead of schedule, of halving the proportion of people without access to improved water sources.[2] According to the UN, one model of large-scale success exists in a joint program between three UN agencies, the government of Panama, and communities in the Ngöbe-Buglé territory in Panama, which brought safe water to nine indigenous communities.[3] In sum, we thank the authors for producing an excellent paper that promises to stimulate profoundly important research and applied work on one of the most pressing social problems of our time.

1. See http://www.globalhealthdelivery.org.

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In their paper, Wutich and Brewis offer a synthesis of the literature on the drivers of food and water insecurity, the strategies people employ in coping with scarcity, and the effects of these strategies on individual well-being. Through the identification of similarities and differences in the water and food domains, the authors seek to advance a broader anthropological inquiry into resource scarcity. The parallel structure of the authors' argument, where current knowledge of food insecurity is compared with that of water, provides us with a firm platform upon which to build future research. The authors nicely articulate the role that anthropologists, from varied research perspectives, can play in advancing theoretical, as well as applied, scholarship in this critical area. This is a timely piece. Here I comment on two topics, resource utilization and research in biocultural anthropology, that expand upon the authors' discussion in effort to foster the research they advocate for.

In discussing the potential parallel drivers of food and water insecurity the authors focus on two of the three pillars of resource security—availability and access. Here I would like to focus attention on the third pillar, utilization, which I would argue has been better explored in terms of water than

2. See http://www.un.org/millenniumgoals/environ.shtml.
3. See http://www.un.org/millenniumgoals/pdf/Goal_7_fs.pdf.

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food (see also Hadley and Crooks 2012) and holds significant potential for advancing scholarship on resource scarcity in that it is a place where food and water become critically connected. Utilization encompasses the selection of foods and beverages, resource quality and safety (contamination), and an individual's health status (e.g., gut health), which affects one's ability to take advantage of a resource's nutritional value. A focus on utilization, particularly resource safety/contamination, draws attention to the role of water and food as mechanical vectors in disease transmission, a key pathway by which resource security can become embodied. Another example is the fact that water often serves as a key ingredient in the preparation of food. Therefore, water scarcity may play an important role in food selection/choice, a component of food utilization that has not been widely explored. Additionally, concerns over water safety may alter hydration strategies. This may include the decision to purchase industrialized products such as bottled water or soda or to seek hydration from food. This latter strategy is particularly understudied (Rosinger and Tanner 2013). These are just a few examples of how a focus on utilization is needed for advancing understanding of resource scarcity.

At the end of the article the authors point to several cross-disciplinary fields within anthropology that could advance a broader anthropology of resource scarcity. One of these is biocultural anthropology, specifically the critical biocultural approach where broad social conditions are linked to individual well-being. The trend over the past two decades has been an increasing reliance on household-level reports of and coping strategies for dealing with resource security. While these data have certainly added to our understanding, there is reason to argue that not all members of the household will experience resource scarcity in the same way (Bernal et al. 2012; Gittelsohn 1991; Piperata et al. 2013). Additionally, reports of strategies used in alleviating resource scarcity do not speak to their actual effectiveness at the household or individual level (Piperata et al. 2013). Thus, the use of a critical biocultural approach for advancing understanding of resource scarcity will require greater emphasis on intrahousehold dynamics and an ethnographic understanding of the cultural context. For example, research on experiences with food security has focused on women due to their role in purchasing, preparing, and distributing food. Yet, in many instances, in both urban and rural settings, males may have the primary responsibility for accessing food via their labor and wages. How men experience and cope with this responsibility and thus embody resource scarcity remains understudied. In terms of effectiveness, a commonly reported strategy is the prioritization of certain household members over others. While table 1 indicates that evidence for this strategy is "strong" for food, data to support the actual practice, as well as its effectiveness in alleviating resource scarcity for those prioritized, are rare. Recent research on maternal buffering, where mothers sacrifice their own intakes in effort to divert resources toward children, illustrates not only the nutritional risks this strategy has for women, especially those who are lactating, but also its insufficiency for alleviating food insecurity among children (Piperata et al. 2013). Furthermore, child age affected the degree of buffering, drawing further attention to our need to explore intrahousehold dynamics and the pathways by which individuals experience and come to embody resource scarcity. Nearly a quarter-century ago, Gittelsohn (1991) demonstrated the importance of "opening the box" (i.e., the household) for understanding access to resources. Considering anthropology's tradition of studying at the household and individual levels and interest in human variation, the field is well situated to contribute theoretically and practically to the study of resource scarcity.

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Wutich and Brewis convincingly advocate for the constitution of a unified anthropological theory of resource insecurity addressing both food and water insecurity. They consider "(1) the causes of resource insecurity at the community level, (2) 'coping' responses to resource insecurity at the household level, and (3) the effect of insecurity on emotional well-being and mental health at the individual level." Through a thorough literature review, they show numerous similarities between food and water insecurity, offering fertile ground for elaborating a comprehensive approach based on Sen's entitlement approach. At the same time, they underline some differences in the emergence of, consequences of, and reactions to these two sorts of resource insecurities.

This ambitious theoretical project may benefit from the contributions of subdisciplinary approaches mentioned by the authors (e.g., critical medical anthropology, economic and ecological anthropology, biocultural anthropology), as they cast complementary lights on the subject from an anthropological perspective. In addition, fruitful links could be established between the research field outlined by Wutich and Brewis and current works in other disciplines (e.g., political economy, geography) and in interdisciplinary approaches (e.g., political ecology). More specifically, political ecology might help identify the causes and consequences of resources insecurities at the local, national, and international level. In addition, this approach shares the commitment to promoting fairness in resources distribution and improvements in the life conditions of the people suffering from deprivation, highlighted in the conclusions of the paper.

While Wutich and Brewis propose an exciting research agenda, a number of aspects could be further developed. First, the suggested definitions of food and water insecurity are large, allowing for a critical reflection on the differences in resource insecurity causes and consequences in the global

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North and South. Nevertheless, a more subtle distinction between the physical, economic, and social components of scarcity could facilitate operationalizing these definitions (Wolfe and Brooks 2003).

Second, although providing a detailed picture of some aspects of resource insecurity, the three-level (community-household-individual) analytical framework proposed by the authors seems to overlook some crucial dimensions that could have strong impacts on the causes, management, and consequences of insecurity. For instance, Wutich and Brewis acknowledge that the intrahousehold dynamics are not well documented for water-scarce environments, but they consider the individual level only when it comes to mental health and emotional well-being. However, as women and children traditionally bear the burden of collecting and transporting water in numerous communities, responses to resource insecurity could potentially be influenced by and have an influence on intrahousehold elements related to gender or family size (Baguma et al. 2013). In sum, taking into consideration inter- and intrahousehold dimensions such as class, caste, age, and gender, along with international, national, and regional dynamics, could help apprehend the sociopolitical structures constructing and causing food and water insecurity and their history (cf. Kaika 2003; Mehta 2007; Swyngedouw 2004), as well as the responses provided to it beyond the community and household levels. In turn, this might strengthen the proposed theoretical framework, reinforcing the parallels between water and food insecurity. To give an example, Wutich and Brewis have found no evidence of credit/loans or distressed sales of assets in water-insecure contexts; nevertheless, taking into account the strategies for coping with insecurity at the local level could show other mechanisms at play. Notably, credits or sales (namely, credit-based expenditures, privatization or import/export of virtual water) might actually have occurred in water-insecure contexts; nevertheless, it is not households but public administrations (Bakker 2003) or private companies (Hoekstra 2003) that might have carried them out through domestic and international markets.

Then, food and water present fundamental sociophysical differences, the former often widely traded in local and global markets, and the latter an "imperfect public good," difficult to handle and transport, and "often managed as a common pool resource"—that is, an "'uncooperative' commodity" (Bakker 2007). These characteristics could help explain the variegated roles played by social norms, markets, and public administrations in creating and coping with food and water insecurity, whose diversity is mentioned in the paper. They also confirm the need for expanding the levels of analysis, as the local institutional arrangements might have a distinct influence over water insecurity compared with food insecurity.

Finally, the authors identify a causal link between water insecurity, social stigmatization, and mental illness. Further research on this causal relation might be useful, as its direction could be reversed or it could be part of a circular causality. In fact, mental illness and other psychosocial characteristics are often associated with poverty and poverty-related physical illness (Patel and Kleinman 2003), and they are frequently the object of strong culture-related social stigma (Abdullah and Brown 2011). These elements could be present before water insecurity, leading to reduced/absent entitlements to water (for instance, if the mentally ill are denied access to housing, working, or social benefits in a context where water is commodified) and, subsequently, to a water-insecure condition reinforcing social stigmatization and eventually worsening mental health.

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The study of water insecurity is relatively new: in the years prior to 2000 there were barely one or two studies containing the term "water security," but that number has risen to more than 50 per year since 2009 (Bakker 2012; Cook and Bakker 2012). As interest in this topic has grown, an increasing amount of effort has been devoted to operationalizing water insecurity. Because of the great variation in the ways that different societies obtain and use food and water, an anthropological perspective on both measurement and theory is needed. Wutich and Brewis's review of the anthropological literature is therefore an important contribution.

Here we suggest some ways in which they may have been too confident in their interpretation of the literature and some ways in which they might have been even more confident, by invoking a broader range of conceptual or theoretical perspectives that could be brought into play. Where Wutich and Brewis are perhaps overconfident is in their assertions about the causal pathways linking water insecurity to various dimensions of well-being. Even in the most recent studies of resource insecurity, the interconnections between water and food security and other factors that influence human well-being remain very difficult to tease apart in cross-sectional studies. Some of their statements—for example, that "food and water insecurity create uncertainty and unpredictability, which can lead individuals to experience emotional distress and mental illness"—warrant qualification. These pathways are plausible, but so are alternatives—for example, the uncertainty associated with living in poverty could produce emotional and mental distress independent of concerns over food and water. This contrasts with the authors' more circumspect perspective elsewhere in the text.

Studies that assess the impacts of interventions may offer a solution to this issue. Water, sanitation, and hygiene interventions offer excellent opportunities to test whether water insecurity is causally related to various dimensions of human well-being and to determine the pathways through which it has its

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effects. Gibson and Mace's work in Ethiopia is one example of how water interventions can be used to test hypotheses. Among the Guji Oromo, the improvement of community water provision through the drilling of tube wells had unintended consequences for community health, being associated with shortened birth intervals, increased child malnutrition, and increased migration (Gibson and Mace 2002, 2006).

The next step—isolating pathways—requires a more careful selection of intervention types and outcome measures. Interventions that focus on improving water quality but not quantity, for instance, could be used to examine which dimensions of human well-being respond to improved water quality and which do not. Given the number of WASH interventions currently under way, researchers have an opportunity to identify interventions that are suitable for testing key hypotheses. Gibson's work and our own ongoing research in Ethiopia (Stevenson et al. 2012) also illustrate the practical value of collaborating with government and nongovernment agencies that are involved in improving water supplies. Engaging with NGOs represents a feasible, ethical, and powerful way to test anthropological hypotheses about resource insecurity. Both sides can benefit: the agencies by strengthening their potential for evaluating projects and identifying impacts (including the possibility of unforeseen consequences), and researchers by gaining a quasi-experimental window on the ways changes in water supply—and by extension security—are impacted.

Where Wutich and Brewis seem to have limited their depth of exploration is in the range of theoretical approaches that could be called upon in contextualizing water insecurity. With regard to their question, "What are the most powerful drivers shaping community vulnerabilities to resource insecurity?," for example, they do a good job of summarizing drivers that fall within the remit of classical economics and entitlement theory, including the relative contributions of state and market forces. But what about alternative frameworks? From a Marxist perspective, couldn't capitalism or neoliberalism be invoked as drivers of differing levels of water insecurity among communities or world regions? And couldn't changes in the meanings attached to food and water be one pathway through which capitalism might drive differing levels of water insecurity and alter its impact on well-being? Markets do more than simply provide a means of distributing goods—they also manipulate value claims of goods and shape the context for what is considered the "right" way to consume a good. For example, markets can structure which foods are considered stigmatized, edible, preferred, and nutritional and what the correct context for consumption is. Volatility in food markets over the past decade has provided ample opportunities to investigate these processes, as the rising price of staples such as corn and wheat has disallowed people from consuming the "right" foods or consuming them in the "right way" (Hadley et al. 2012).

Carefully designed studies that compared communities or populations with varying levels of water privatization could be useful in understanding how the commodification of water affects various dimensions of human well-being. We expect that privatization of water markets would shift perceptions of hygiene, water needs, and what scarcity looks and feels like, even when the quantity of water accessible to individuals remains unchanged, and this would have consequences for human well-being. Through collaborations along the lines of the NSF Workshop on Food Insecurity and Mental Health, and by exploiting the opportunities presented by private and governmental interventions affecting access to water, it ought to be possible to systematically execute the kinds of projects that would be needed to assemble the data for such a comparative project.

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Wutich and Brewis are to be commended for their lucid synthesis of the analytic approaches to understanding the common or unique causes and consequences of food and water scarcity in an attempt to develop an integrated framework. Indeed they have convinced me that the study of water is even more complex than that of food, as water is not only vital in the diet but also central to so many nonalimentary functions at the individual, household, community, regional, and so on, levels. As the authors make clear, water scarcity stems from and affects livelihoods in multiple ways, which are both independent of and act through food access. Given that food production and processing require water, and that food it itself a major source of water (this amount varies across populations, especially by levels of fruit and vegetable consumption), one could argue that the study of food scarcity can actually be framed within broader inquiry about water scarcity.

To the extent that the authors are advocating an overarching biocultural analysis of food and water scarcity, I will focus my comments on their biological outcomes. While the consequences of food and water scarcity for mental health are elaborated in the essay, the consequences for physical health are noted only in passing. They are, however, numerous and varied and include various morbidities as well as the very real threat of mortality. Thus it would be helpful to have some sense of rates of morbidity and mortality that can be attributed to water scarcity, in combination with or separate from lack of food. From there we can ask questions about biological adaptability in the face of water shortages: (1) What role has water scarcity played in the evolution of *Homo sapiens*, as evidenced by species-specific adaptations to maintain adequate hydration in the face of shortages? (2) Can growth and development be channeled in adaptive ways when they occur in water-insecure contexts? (3) To what extent are there more plastic physiological responses that individuals can engage in the short term for acute, but short-lived, episodes of scarcity?

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There is pretty clear evidence for questions 1 and 3 (which involve the central nervous system, hormones, and various organs, particularly the kidneys, and physiological thirst; see Jéquier and Constant 2009; Popkin, D'Anci, and Rosenberg 2010; Sawka, Cheuvront, and Carter 2005), but there is only scant work on question 2, in the absence of concomitant food scarcity or infection.

As Popkin and colleagues lament (2010), our measures of water intake under nonexperimental conditions are fairly crude, and there are no current standards for assessing human hydration status. So while indices of nutritional status are fairly well developed (through anthropometric measures and an array of serum or urinary biomarkers), there are no analogous agreed-upon biomarkers of hydration status that would provide evidence of physiological compromise from water scarcity. This is critical to a biocultural approach to water scarcity, as deprivation can exist as a function of social conditions that restrict access, and also because intensive or prolonged physical activity (such as intensive wage labor under hot conditions) can cause individuals to become dehydrated as the body sweats to prevent overheating. Individuals can lose up to 6 L of water per day in these circumstances, which in turn increases the need for sodium (food). Furthermore, adaptation to dehydration varies across the life cycle: thirst, fluid consumption in response to thirst, and water loss through sweat all differ, with older individuals in particular being less likely to consume sufficient fluid in response to deprivation.

The physiological problems associated with water scarcity can manifest in myriad ways, given the diversity of roles water plays in the body and the particular ways in which water scarcity presents itself. For example, when water shortage relative to need is acute, within hours cognitive and sensory functions can be disrupted and delirium can ensue. Organ function is compromised, and death can occur within a matter of days unless fluids are replenished. More commonly, however, insufficient hydration is likely to result from inadequate food and water intake, as well as from physical activity from labor, and can cause more subtle physiological compromise. If we assume that water scarcity also refers to restricted access to potable water, but water is contaminated, its consumption—as a drink or when used in food preparation—can (somewhat ironically) result in dehydration through diarrheal disease. The water-borne Cholera bacterium is especially well known for causing morbidity and mortality from dehydration. Contaminated water used for personal and household hygiene can result in other infectious diseases such as schistosomiasis, with its concomitant morbidity.

In sum, as the authors recognize, the diverse biological consequences of food scarcity should be broadened to include specific attention to those related to water. This line of inquiry can then be merged with the integrated analytic approach they advocate, with the result being a fully biocultural analysis of water insecurity.

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Wutich and Brewis have made a very useful contribution to our conceptual understanding of resource insecurity. They are to be commended for the clear structure as well as the diversity of evidence that they bring to bear on their argument for the parallels between food and water insecurity. They have done much more than argue "for the potential of a literature that bridges anthropologists' understanding of food and water as basic resources." They have assimilated literature from anthropology, economics, geology, political science, and public health to offer a vision of research on "resource insecurity" that will be of use to scholars and practitioners from many disciplines.

As I read about resource insecurity, I was reminded of another term: nutrition insecurity. Nutrition insecurity "exists when food security is combined with a sanitary environment, adequate health services, and proper care and feeding practices to ensure a healthy life for all household members" (Shekar 2006). By spanning food, hygiene, and care, the term captures a social, political, and public health ideal. But, in lumping those domains together, precision and specificity are lost. If a population is nutritionally insecure, is it because of inadequate food, water, or care, or all of the above? Thus, from a theoretical perspective, thinking about "resource insecurity" can be insightful, but in practice, I would urge that the distinctions by resources be retained.

While no one article can do everything, there are three topics that I would have liked to see discussed in greater detail, namely, disease as a consequence of resource insecurity, the gendered nature of water insecurity, and measurement of resource insecurity. First, the proposition of disease as an effect of resource insecurity was almost entirely overlooked. Yet, the disease consequences of insufficient safe water are unmistakable. In 2009, unsafe water and sanitation was the fourth leading cause of loss of disability adjusted life years (Mathers, Stevens, and Mascarenhas 2009). Drawing comparisons between the physical health consequences of food insecurity and water insecurity would have further advanced the authors' argument. Indeed, with food insecurity, we see causal links with both undernutrition and obesity, as well as infectious diseases such as HIV (Weiser et al. 2011). Similarly, there are a myriad of diseases associated with dangerous or limited water supplies, from diseases of water-borne pathogens, such as diarrhea and cholera, to toxicities from water laden with metals or metalloids, such as arsenic and lead.

Second, there is much more to say about the gendered nature of water acquisition and use. While there was some discussion of women's experiences with the stigmatizing consequences of water insecurity, their role in water acquisition and use was mostly missed. Yet water insecurity parallels food insecurity with regard to gender in a number of ways. For

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one, just as the preparation of food is primarily a task of women, so is the acquisition of water. And as water becomes more scarce, the arduous task of fetching water often becomes more difficult. Traveling longer distances and waiting in long lines is not only more physically fatiguing, but being alone in remote places can threaten women's and girls' physical and sexual safety. Water insecurity can also exacerbate food insecurity. For example, the energy expenditure of carrying heavy containers of water is not trivial, such that caloric needs may increase tremendously. And as more time and energy are spent on water acquisition, women's other responsibilities may languish, including food preparation and also child care and feeding. Further, greater time spent acquiring water could reinforce food insecurity by taking away time that would otherwise be spent on household food production or income generating activities. Finally, most household chores that depend on water—cooking, cleaning, and laundry—are also in the female domain. These chores also become more difficult as water becomes more scarce. In sum, the centrality of water to the physical and psychosocial well-being of women and children cannot be overstated.

The measurement of resource insecurity was the third topic for which more discussion would have been useful. As we have seen in the food insecurity literature, agreement on definitions and, by extension, measurement has been difficult, which in turn makes consistency in identifying and comparing causes and consequences of food insecurities problematic (Barrett 2010; Jones et al. 2013). I would therefore encourage careful consideration of instruments that can measure water insecurity in a broadly acceptable way. A second aspect of measurement is the level at which resource insecurity should be measured. Many food insecurity measurements occur at the level of the household, which is not appropriate if intrahousehold variation is quite high (which it often is). For this reason, in our own work on food insecurity among HIV-infected pregnant women and their infants in Kenya and Uganda, we are measuring food insecurity at the level of the household, using the Household Food Insecurity Access Scale (HFIAS) (Coates, Swindale, and Bilinsky 2007), as well as at the level of the individual, with an Individual Food Insecurity Access Scale, modified from the HFIAS. However, in sum, Wutich and Brewis's scholarship is an important step in understanding the far-reaching consequences of resource insecurity for the health of individuals, communities, and nations.

Reply

We are delighted that the research agenda we proposed resonated so well with such a diverse group of scholars and are grateful for the array of excellent suggestions for broadening it. Of these, two are especially compelling to us and provide a focus for our reply: first, the opportunity for interdisciplinary theory building and, second, the need for research that informs policy making and community needs. We also welcome the opportunity to respond to the commentators' critiques, particularly regarding definitions and measurement of insecurity, research design, and causality. Finally, we will comment on some future directions for this field, as synthesized from our own work and that of our commentators.

In our paper, as Logan observed, we concentrated on arguing for the value of an intersubdisciplinary anthropology of resource insecurity. But, as Logan, Rattu, and Young all note, many (if not most) of the conversations about food and water insecurity are currently happening outside of anthropology. Maes and Armelagos lament the lack of a mature science of global water delivery, so it is exciting to note that new global research networks dedicated to this task are being formed right now (e.g., Sivapalan et al. 2014). Yet, too few anthropologists are involved. It's clear that disciplines such as ecology, global health, and engineering can contribute much to our own theory-building efforts in anthropology, but what do we as anthropologists contribute? In our own experiences with transdisciplinary work we know that colleagues are eager to hear what anthropologists can add—drawing on our rich traditions of historical, ethnographic, and biological research—to interdisciplinary theory building. But, to really demonstrate the value of anthropological approaches to understanding water insecurity, we need to first strengthen our own base of theoretical and empirical scholarship. Our paper was an effort to get the ball rolling, and the directions proposed by the commentators challenge us to go much further.

One of the clearest recommendations is that we delve more deeply into the biological implications of water scarcity. Wiley's contribution is especially useful, as it briefly summarizes the current state of knowledge about the effects of water scarcity on biological outcomes. She then outlines three pathways for research—on adaptation, growth and development, and physiological response—and highlights the need for more research on growth and development. In this sense, Wiley has provided us a whole new set of jumping-off points for biocultural theory building around not only water but also food insecurity. Young, too, envisions an expanded biological approach, but with an emphasis on disease. As Piperata also notes, this places emphasis on a lack of safe water (not just the absence of water) and on understanding the effects of consuming contaminated water. A promising avenue for new research on water and disease is the emerging issue of wastewater and effluent reuse (e.g., Rice et al. 2013), so-called sewage mining. The technologies of recycling wastewater for increasingly intimate uses (such as bathing and drinking) are gaining traction. Anthropology could have much to offer regarding the biocultural risks posed by the consumption of what the US EPA calls "contaminants of emerging concern," including pharmaceuticals and personal care products, in recycled wastewater and effluent (see Little 2014 for an example). As Maes and Armelagos underscore, this kind of

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research should play a crucial role in the larger global health project of achieving safe drinking water for all.

Another promising research area would explore more deeply the politics of food and water insecurity. Rattu, drawing on political ecology as a theoretical lens, recommended more explicit consideration of macro political structures (e.g., state and international governance) and social structure (e.g., gender and class). While many research questions about social structure could be investigated with individuals (including individuals within households, as suggested by Piperata), households, or communities as the units of analysis, Rattu's example powerfully illustrates how analysis at state and international levels reveals "coping strategies" of water-insecure communities that would be hidden at lower levels of analysis. Stevenson and Hadley also argue for the need for more attention to the various ways that markets are insinuated into water distribution (e.g., divestment, privatization, commodification), and the effects of this on water insecurity. As Logan and Stevenson and Hadley suggest, the long tradition of scholarship associated with poverty—including Marxist, materialist, and vulnerability approaches—has much to contribute to this research agenda. And, finally, Maes and Armelagos remind us to pay attention to social phenomena, such as food and water riots, that mark the collective rejection of privatization and other transitions from moral economies. Such forms of collective action have the power to pivot societies from one form of resource governance to another, a key anthropological problem.

Of course, work on governance should not be confined to academic spaces. Comments suggested several ways that anthropologists can get involved on the ground. Logan, speaking from an archaeological perspective, notes the need for scholarship that produces "usable pasts" that can assist policy makers in decision making. Stevenson and Hadley, drawing on their own work in Ethiopia, suggest the need for collaboration with both governments and nongovernmental organizations on water delivery projects. Maes and Armelagos discuss how water insecurity should be reframed as a global health issue. There is certainly much unexplored space for applied work at the interface of medical and ecological anthropology (see Dowdall and Klotz 2013 for an example). Even while we, and many others, are already engaging with communities and making our findings accessible to policy makers, these are important reminders that this should be kept front and center in how we design and execute our research—and not just be an engagement that happens as we disseminate results.

Beyond this discussion of ways to further expand the research agenda, we would also like to acknowledge the cautions and critiques. First, a common theme is the need for conceptual and operational clarity around definitions of resource insecurity and water consumption. We have developed some new approaches for measuring food and water insecurity (e.g., Hadley and Wutich 2009) and water consumption (e.g., Wutich 2009), but this work is far from done. There are some solid recent reviews (Bakker 2012; Barrett 2010) that might help those moving into this area. Like Wiley and Piperata, we would welcome the development of better tools and measures of both water intake and human hydration status.

Another challenge, raised by Stevenson and Hadley and by Rattu, has to do with the extent to which water insecurity can be considered a cause of emotional distress and of mental illness. We do stand by the assertion that there is solid contextual evidence for a causal connection between uncertainty/unpredictability around water insecurity and emotional distress. The ethnographic record bristles with examples: rain dances, prayers, songs of lament, novels, and films all depicting people's fear and anxiety about the prospect of water running out. People may be concomitantly or multiply distressed by the many unpleasant experiences associated with poverty (e.g., food or energy insecurity), and it is true that we have yet to disentangle this complexity. To us, the interesting research problem is not establishing that water insecurity can cause distress but rather better understanding the many mechanisms that mediate this relationship. As future studies are designed, Rattu's suggestion that the relationship between may be circular, too, deserves careful consideration.

The case for a causal relationship becomes shakier, however, when we look at the connection between water insecurity and mental illness, as defined in the *Diagnostic and Statistical Manual of Mental Disorders*. Even so, there is some good evidence from natural experiments (e.g., Cawte 1978; Coêlho et al. 2004) that people who live in drought-struck communities are more likely to suffer emotional distress, anxiety, and depression than those living in similar communities unaffected by drought. While we find the results of these natural experiments convincing, we—like many water practitioners (Farrelly and Brown 2011)—have some misgivings about experimental intervention-based research designs as a means to solve this problem. One issue with this approach is that it is difficult to separate, analytically, the physical provision of water from the social processes required to produce it (i.e., project funding and administration, and related power dynamics). For that reason, such projects can cause significant distress (e.g., if implemented unjustly) even when they deliver water as promised, a point well illustrated in the work of Ennis-McMillan (2006) in Mexico.

Interestingly, many of the concerns raised here are ones we have grappled with, in one way or another, over the last decade. We increasingly have been investing in a very traditional (and we think routinely underrated) anthropological approach—systematic cross-cultural comparison (Ember et al. 2014)—as a parallel means to move this conversation forward. With studies initially focused in Arizona, and funded under the U.S. National Science Foundation's DCDC[4] and CAP-LTER[5] programs, the Global Ethnohydrology Study[6] has

4. See http://dcdc.asu.edu/.
5. See http://caplter.asu.edu/.
6. See https://shesc.asu.edu/research/projects/global-ethnohydrology-study.

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expanded to examine cross-cultural variation in local water knowledge and management across a myriad of global locations and through several theoretical lenses (e.g., Brewis et al. 2013; Crona et al. 2013; Gartin et al. 2010; Vins et al. 2014; Wutich et al. 2012; Wutich, Brewis, Sigurdsson et al. 2013). In one recent study, for example, we collaborated with geographers and political scientists to compare water management experiences for sites in four countries with high/low water scarcity and high/low economic development. Our results indicate that the kinds of water solutions people envision and their understandings of (in)justice in water provision vary significantly across sites with different development profiles, but much less so for sites with differing levels of water scarcity (Wutich, Brewis, York et al. 2013; Wutich et al. 2014).

We finish with a salute to anthropologists pioneering collaborative, community-based research on water insecurity; the value of their efforts is perhaps the strongest single message that can be drawn from our paper and its commentary. In El Alto, Bolivia, Nicole Fabricant and Kathryn Hicks are working with neighborhood activists to address water scarcity related to governance issues and climate change (Fabricant and Hicks 2013). In Santa Fe, New Mexico, David Groenfeldt has created the Water-Culture Institute, which promotes ethical and indigenous approaches to local water management (Groenfeldt and Schmidt 2013). In the Tampa Bay area of Florida, Rebecca Zarger helps lead a collaboration designed to investigate power dynamics around water provision and works with community agencies to improve water management (Zarger et al. 2012). Bringing together a range of local ethnographic projects on water, Flora Lu leads an NSF-funded effort to identify principles of equitable water governance (Lu et al. 2014). Keeping these extremely complex community-based efforts clearly and continuously connected to theory building at the core of the discipline is always going to be a challenge but is exactly what is needed for an anthropology that can continue to grow in currency, relevancy, and impact.

—Amber Wutich and Alexandra Brewis

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