

**ADVANCED REVIEW**

# On considering climate resilience in urban water security: A review of the vulnerability of the urban poor in sub-Saharan Africa

Catherine F. Grasham | Marina Korzenevica | Katrina J. Charles

School of Geography and the Environment,  
University of Oxford, Oxford, UK

**Correspondence**

Katrina Charles, School of Geography and the  
Environment, University of Oxford, Oxford OX1  
3QY, UK.

Email: [katrina.charles@ouce.ox.ac.uk](mailto:katrina.charles@ouce.ox.ac.uk)

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Climate shock-related water insecurity has a significant impact on poverty, and vice versa, with poor people adversely impacted by different hazards. Many studies have focused on rural communities resulting in a lack of evidence on the vulnerability of urban dwellers. In this review, we explore the literature on the vulnerability of the urban poor to floods, droughts, and cholera in Sub-Saharan Africa. We particularly highlight the structural challenges and systemic inequalities that are increasing the vulnerability of the urban poor including the differential experiences of women and children. We conclude that poor people have: unequal opportunities to cope with shocks, being deprived from access to water services that wealthier households have; their needs are inequitably ignored; and cumulative vulnerability that reverberates climate shocks into smaller consequences that can have dramatic effects. Therefore, the pathways out of poverty are limited for the urban poor. This is not only due to factors of political economy such as the location and construction materials of houses, but also legacies of discrimination and their reproduction. Individual vulnerabilities are frequently increased due to the roles and responsibilities assigned to people of particular genders and/or ages. We find that these differential vulnerabilities are crucial yet poorly researched. There is also a lack of evidence for the manifold effects of drought on the urban poor. Building on the urban climate resilience literature we argue that policy makers and practitioners must consider who water security is for.

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**KEYWORDS**

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**1 | INTRODUCTION**

Climate variability and shocks, such as floods and droughts, sustain and worsen poverty. The mechanisms for this differ in rural and urban settings. Predictions suggest that Africa is one of the most vulnerable continents to climate change (IPCC, 2007) and that the area of urban land exposed to floods and droughts will increase (Güneralp, Güneralp, & Liu, 2015). Impacts

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of climate shocks have high and long-lasting effects on poor regions such as sub-Saharan Africa and are well explored in the rural areas. For example, in Ethiopia, rural communities that experienced even a relatively well-managed drought within the previous 5 years were found to reduce their per capita consumption by 20% (Dercon, Hoddinott, & Woldehanna, 2005). However, in urban areas, the risks that households suffer due to perpetual climate variability, floods, and droughts are less well documented.

Urban areas with moderate to high levels of poverty are more vulnerable to climate shocks than those without (Filho et al., 2018). The urban poor are “disproportionally exposed to droughts and floods” (Winsemius et al., 2015, p. 328) and more vulnerable to disaster risks (Baker, 2012) that are of unacceptable levels (Awuor, Orindi, & Ochieng Adwera, 2008). Urban wage earners have been found to be the most vulnerable to poverty resulting from climate extremes, even more so than rural communities dependent upon agriculture (Ahmed, Diffenbaugh, & Hertel, 2009). Mitigating disaster risks and better management of climate variability in urban areas of sub-Saharan Africa is critical for urban climate resilience and enabling sustainable development.

Heterogeneity characterizes urban areas and contributes to unequal vulnerability to climate shocks. Three types of urban areas can be differentiated: (a) informal settlements (unplanned urban areas commonly referred to as slums), (b) peri-urban areas (unplanned urban areas falling outside of the formal urban boundary and frequently exhibiting rural and urban characteristics), and (c) planned urban areas. There are differences within each urban type (e.g., Owusu, Agyei-Mensah, & Lund, 2008) and in this review, we particularly draw on the unequal exposure of women and children to climate shock-related water insecurity. Distinguishing between planned and unplanned areas, and specifically acknowledging the unique challenges of women and children, is useful to illuminate the striking inequalities in terms of exposure, adaptive capacity to hazards and the differential approach from policy-makers in terms of provision of water services.

In this paper we address the confluence of literature on urban vulnerability, climate resilience, water security, and poverty to present an integrated review on the water security impacts of climate shocks and variability on the urban poor. Methodologically, we offer an interdisciplinary review of the peer-reviewed literature. We have done a systematic search in Scopus, Web of Science and Google Scholar using different combinations of key words including: “urban”/“town”/“city,” “drought”/“flood”/“cholera,” “poor”/“informal settlements”/“vulnerable,” as well as additional searches with related key words: “Climate”/“climate change”/“water” and a targeted search of several African cities known for the abovementioned difficulties, for example, Cape Town, Accra, and Dar es Salam. Articles were selected where some reference was made to the urban poor/vulnerable/disadvantaged/informal settlements/other inequalities or specifically speaking about gender/women/children. Additional articles were found with snowballing. We acknowledge that this review is not comprehensive as we are biased by the authors' selection of keywords and we rely on Western search systems thus excluding valuable Southern perspectives that are often published in smaller, excluded journals. Nevertheless, we provide insights into common trends of the water security impacts of climate shocks on the urban poor.

The paper flows in the following way. First, we frame our discussion under the umbrella of vulnerability. Second, we explore the literature demonstrating the shocks felt by the urban poor arising from too much water (floods, heavy rainfall, or flash floods) and, third, from too little (droughts and water scarcity). Fourth, we include in our analysis the specific impacts of disease outbreaks, with a focus on cholera, as an “indicator of inequity” (WHO, 2018). Finally, we discuss the structural challenges that shape and reproduce vulnerability while constraining adaptive capacity. We conclude that poor people have unequal opportunities to cope with shocks, being deprived from access to water services that wealthier households have and their needs are inequitably ignored. This is due to factors relating to both individual and imposed vulnerability, such as location and construction of houses, but also legacies of discrimination and its reproduction. Therefore, we find that the pathways out of poverty are limited for the urban poor. We finalize the paper by highlighting surprising research gaps that we have identified throughout our review.

## 2 | THE CLIMATE VULNERABILITY OF THE URBAN POOR

The concepts of vulnerability and water security guide our review paper. Our definition of vulnerability derives from the field of political economy, specifically using the approach by Adger and Kelly (1999, p. 254) who define vulnerability as “the state of individuals, groups or communities in terms of their ability to cope with and adapt to any external stress placed on their livelihoods and well-being.” Vulnerability implies that some people are less or more susceptible than others, at different times and places (Crivello & Espinoza-Revollo, 2018; Williams, 2001), to a specific hazard or range of hazards (Brooks, 2003) and vulnerability exists at different scales (Herslund et al., 2016). Importantly, people's vulnerability is not only a matter of individual resilience, but also exists in the idea of care as a manifestation of collective social responsibility (e.g., Crivello & Espinoza-Revollo, 2018). Moreover, social vulnerability is relative to differentiation parameters (such as gender, class, race, age, etc.), coupled with situational variables (living place, health, household composition, resources, etc.) (Owusu, Nursey-

Bray, & Rudd, 2018). Therefore, even though the poorest in an urban area will have certain common social norms, physiological differences and social norms can develop into distinct experiences. Generalizing “the poor” risks disguising the tragedies of specific groups. Throughout our article we highlight women and children, as these groups appear the most within our cited studies.

Differences in vulnerability and exposure depend on three major intersecting points (see comprehensive overview in Adger, 2006; Fussler, 2007; IPCC, 2014): (a) sociopolitical and economic conditions, (b) the exposure and sensitivity to perturbations or external stresses, and (c) adaptive capacity at different levels of governance. Similar conclusions were made in relation to floods (Frick-Trzebitzky, Baghel, & Bruns, 2017) and water scarcity (Mehta, 2013), specifically around the biophysical and social coproduction of impacts. The sociopolitical processes that drive the transition from physical scarcity to socially experienced scarcity (see also Aguilera-Klink, Pérez-Moriana, & Sánchez-García, 2000) is our particular focus. We are asking two questions: (a) How are the urban poor vulnerable to climate shocks, what makes them disproportionately vulnerable and why? (b) How does vulnerability unfold for different groups of the urban poor?

Water security has become the dominant paradigm for water management among water professionals. It has a variety of definitions that have developed in relation to economics (e.g., Borgomeo et al., 2014; Sadoff et al., 2015), interdisciplinary, and integrative approaches (Bakker, 2012; Loring, Gerlach, & Huntington, 2016), the interaction between water and society (Linton & Budds, 2014) and political ecology approaches that analyze the structural injustices that exacerbate water insecurity (Swyngedouw, 2009). Urban water security introduces the issue of planning for population growth, which can be rapid and informal. While recognizing the ongoing debates around water security, this paper focuses on water security within the water-related risk framework as a tolerable and equitable level of chronic or intermittent water-related risk for all urban dwellers. Within this approach we aim to follow the suggestion by Hoekstra, Buurman, and Van Ginkel (2018), to distinguish between hazard-exposure and vulnerability as underlying factors. This is not with the purpose to alienate them, but to demonstrate how poor management of regional physical conditions coupled with underlying systemic factors results in adverse effects on the urban poor. Poor people are usually more vulnerable and more water insecure. While we are resting on this pronounced statement, we want to emphasize two aspects. First, poor people have their own risk perceptions, risk calculations (Slovic, 1999), and adaptation mechanisms (Agrawal & Perrin, 2009) that are significantly impacted by the systemic inequalities and the complex and unequal outcomes from different interventions. Hence, we believe that people are continuously trying to make their lives better, yet multiple factors cast them back. We aim to explore complex and systemic aspects of water insecurity that decrease their resilience and pathways out of poverty.

Second, there are multiple persisting intersectional differences within urban communities and households. The complex nexus of social structures with the environment serves as an arena in which existing social inequalities such as gender, age, class, and ethnicity are articulated, produced, negotiated and challenged (e.g., Nightingale, 2011; Sultana, 2009). This implies that environmental injustice can escalate structural inequalities. Additionally, with limited participation from the community it is more likely that women will be voiceless in communicating their views. The ripple effects of environmental injustice, urban WASH and climate change on the differentiated vulnerability of women and children are real, yet poorly explored (Geraldine, 2009; Harris, Kleiber, Goldin, Darkwah, & Morinville, 2017; Reed & George, 2011). The following sections will analyze how vulnerability is articulated and differentiated, the role of water security within this and the systemic inequalities perpetuating it.

### 3 | UNEQUAL EXPERIENCES OF URBAN FLOOD SHOCKS

Floods frequently transform into major disasters resulting in substantial losses and tragedies that attract massive attention. However, there are multiple, slowly unfolding and reverberating affects from floods that usually remain silent. In the coming decades, flood will likely be an increasing hazard due to projected increases in heavy precipitation events, and sea level rise set to compromise coastal areas (Niang et al., 2014). This is due to a combination of biophysical processes and human-induced changes of hydrological systems and landscapes (Chang, Franczyk, & Kim, 2009). Between 2000 and 2009, 21 million people in sub-Saharan Africa were affected, with the number of people rising with an increasing number of floods (EM-DAT, 2018). The events recorded in this database are limited by the magnitude of the impact, either in terms of human impact (at least 10 reported deaths or 100 people affected) or political impact (declaration of a state of emergency or call for international assistance) ignoring the smaller impacts of floods that unduly affect the urban poor.

The urban poor and those living in unplanned urban settlements are disproportionately affected by flooding (e.g., Douglas et al., 2008) where development exacerbates environmental issues, for example, through loss of infiltration capacity and poor planning. Unplanned settlements are commonly built on marginal land including flood prone areas, as the examples from Lusaka (Zambia) (Nchito, 2007), Port Elizabeth (South Africa), and Johannesburg (South Africa) (Viljoen & Booysen, 2006) show. The density of unplanned human settlements in flood prone areas (Di Baldassarre et al., 2010) and the poor construction

from mixed materials (Pharoah, 2014) is increasing flood risks and fatality in Africa. Finally, unplanned urban settlers often lack legal rights to land, being more fragile to political decisions and facing multiple risks of extortion and eviction. Therefore, as Viljoen and Booysen (2006) argue, approaches to flood management in informal settlements must be specifically tailored to those communities since they have different expectations and socioeconomic circumstances.

Passive acceptance of hazards should not be assumed though, as communities are actively developing their own mechanisms to adapt to flood risks. Even though poor households lack the financial capacity to completely mitigate flood risks, they do adapt to some extent; those that do adapt can reduce their vulnerability, as revealed with a study in urban Nigeria (Adelekan, 2011). Similarly, in Accra (Ghana), Amoako (2018) found that communities in informal settlements were building their own resilience through modifying their house structures and making other changes such as relocating. In South Africa, Fatti and Patel (2013) reported that communities created a social support structure to cope with flooding which then drove government to act arguing in favor of “co-operative governance,” that is, the community and local government working together to manage flood risks. However, similarly to Schaer (2015) who argues that community-based adaptation can result in risk diversion to the most vulnerable groups, we argue that policy makers cannot solely rely on small group adaptation to reduce the investments needed to manage vulnerability and support adaptation.

The destructive effects of floods vary across the population depending on their vulnerability and exposure (Mallett & Etzel, 2018). There is some anecdotal evidence from Accra (Ghana) that women deal with the burden of floods more, because men are at work (Frick-Trzebitzky et al., 2017) and that women are more affected by floods (788 women to 480 men affected in the case of a 2007 flood in Ogun state, Nigeria) (Adelekan, 2011). In a study of urban areas in Kumi District (Uganda) Akampumuza and Matsuda (2017) have analyzed differences between male- and female-headed households in coping with multiple hazards (droughts, flood, and shocks related to harvest). They found that female-headed households have less access to coping resources and opportunities such as land and paid nonfarm labor. Schaer (2015) illustrates that in times of flood, women have additional household chores that prevents them from going to work. Importantly, Schaer also addresses the perspective of men arguing that they take the role of “household protector” and remain in the house while evacuating other members elsewhere. In general, however, there is a paucity of qualitative studies on floods in urban Africa that consider intersectional vulnerabilities.

A notable exception is a study of Lagos (Nigeria) by Ajibade, McBean, and Bezner-Kerr (2013) who argue that the exploration of adaptation and vulnerability should go beyond the simplistic binary assessment of men and women. They have included an analysis of socioeconomic and household specifics, such as income-generating activities, that define experiences, responsibilities, needs, and constraints. They have concluded that the impacts of flooding in a rich district were not gendered, because women tended to have well-equipped houses and servants who managed any difficulties. On the contrary, in poorer districts, women experienced losses in petty trade, challenges in keeping their children healthy, and food insecurity, particularly if they lacked a husband. Additionally, women from poorer districts faced problems in accessing clean water and sanitation were at higher risk of infections and also experienced shame and anxiety from harassment.

Children are usually considered more vulnerable to floods than adults due to their limited physical ability and immature immune system that increases susceptibility to infectious diseases. Studies conducted in the Global North have not proved that children suffer more from floods (Jonkman & Kelman, 2005). However, some results from the developing world are on the contrary. There is evidence that infants who are not breastfed are at particular risk during a flooding event due to a lack of refrigeration and limited access to hygienic preparation at these times (Gribble, McGrath, MacLaine, & Lhotska, 2011). Moreover, the destructive effects of floods on children go beyond visible health problems. The study of urban schools in Namibia has revealed that even 2 years after a flood, more than a half of children experienced symptoms of posttraumatic stress disorder (55.2% of 8–12 olds and 72.8% of 13–18 olds) (Taukeni, Chitiyo, Chitiyo, Asino, & Shipena, 2016). Evidence from rural Bangladesh has highlighted that children will also suffer from increased domestic violence during and after floods (Biswas, Rahman, Mashreky, Rahman, & Dalal, 2010) but there is currently no evidence for this in the African context.

Our review of the unequal exposure and vulnerability to flooding events in this section has revealed that inequity is particularly due to the location and construction of households and that gendered inequalities are profound in poor urban locations. The majority of studies focus on large-scale flooding events and evidence from smaller scale events, in smaller urban areas, are almost absent from the peer-reviewed literature. Studies that explore the multiplicities of vulnerability have reminded us of the necessity to look for the potentially invisible impacts from floods such as: diminished mental health, increased domestic violence, sanitation difficulties and challenges in caring for others, particularly children.

#### 4 | THE MANIFOLD EFFECTS OF DROUGHT IN AN URBAN CONTEXT

Drought emergencies in sub-Saharan Africa are on the rise. Since the peak of drought frequency and deaths in the 1980s, the number of affected people continues to increase, with over 116 million people in one decade in sub-Saharan Africa from 2000



to 2009 (EM-DAT, 2018). It is likely to get worse as increasing evapotranspiration associated with rising temperatures will be a common impact across the continent and may cancel out precipitation increases in some areas (Niang et al., 2014). Moreover, precipitation changes or variability will depend on the region; for example, droughts are projected to intensify in East and Southern Africa, considering the combined impact of evapotranspiration and precipitation changes (Niang et al., 2014). Droughts of varying magnitudes underwrite, and will continue to contribute to, water scarcity and unsafe water.

Due to challenges in governance of drinking water across sub-Saharan Africa, coupled with climate variability, it is difficult to disentangle the causes of unsafe and intermittent urban water supplies. Urban households experience chronic shortages in drinking water and, at times of water rationing, unplanned urban areas receive less water than planned ones (Chitonge, 2014). Cape Town (South Africa) is an archetypal and not unusual case of an urban center in sub-Saharan Africa experiencing severe water scarcity. At one point, 3 million residents of the city were close to complete suspension of piped urban water supply (Foster, Bousquet, & Furey, 2018) caused by a combination of population growth, prolonged below average rainfall since 2015 (Luker & Harris, 2018), the absence of water resources management that takes account for competition for water between different sectors, and insufficient political intervention to regulate water use (Muller, 2018). The Cape Town case highlights how urban water scarcity can be coproduced by drought and sociopolitical conditions.

In general, the peer-reviewed literature is highly lacking in research on drought risks for urban dwellers in sub-Saharan Africa. However, a few studies suggest some important angles worth investigating further. Kinuthia-Njenga and Blanco (2009) revealed that, in Kenya, water scarcity during droughts induces rural to urban migration increasing pressure on already insufficient urban water supplies. In Mombasa (Kenya) a drought caused an increase in food prices, disproportionately affecting the urban poor (Awuor et al., 2008). In Lusaka, Zambia, urban agricultural output was significantly reduced in a drought year, having negative impacts on household food security and ability to generate income (Simatele, Binns, & Simatele, 2012). These studies demonstrate that there is a need to explore the social implications, economic disruptions, and changes in water-reliant income-generating activities in urban areas during a drought. They also point to highly differentiated drought-related vulnerability, dependent on multiple socioeconomic parameters such as income, age, and gender.

In relation to urban droughts, there is limited evidence of gendered implications; however, it is important to consider the gendered impacts within the local context. A primary impact of water scarcity associated with drought is a greater burden on the primary water collector. This is commonly reported to be women in many areas of Africa (Graham, Hirai, & Kim, 2016); however, Geere and Cortobius (2017) and Harris et al. (2017) argue that there is no clear gender distinction in relation to water carrying or even governance in urban areas.

The dearth of studies exploring the adverse impacts of droughts on the urban poor reveals a significant and surprising research gap in the peer-reviewed literature. Literature on urban water and drought in Africa tends to focus on solutions, without a foundation on empirical evidence. The existing studies confirm that the coproduction of water scarcity for the urban poor through social and natural processes cannot be disentangled. The impacts of many other factors, such as weak governance, rural to urban migration, food security and implicit gender assumptions, substantiates the necessity of complex and contextual studies that engage with the wider sociopolitical setting.

## 5 | CHOLERA: A INDICATOR OF INEQUITY FOR URBAN WATER SECURITY?

Cholera has been described as an indicator of inequity. The poor are commonly more exposed through a lack of adequate drinking water services, sanitation and hygiene, but also more vulnerable due to malnutrition and associated lowered stomach acid (Gaffga, Tauxe, & Mintz, 2007; Nalin et al., 1978; Thakadu, Ngwenya, Phaladze, & Bolaane, 2018). Cheap and fast treatment for cholera exists that can reduce the death rate in some cases from 50% to less than 1% (Gaffga et al., 2007). Cholera reappeared in Africa in 1970, and has had a more sustained impact than in any other continent with the majority of cases worldwide occurring in Africa in most years since 1983 (Gaffga et al., 2007; WHO, 2018). Cholera outbreaks are related to climate variability and represent an additional climate-related shock to households. While cholera is commonly associated with rainfall, it is also widely experienced during periods of droughts (Rebaudet, Sudre, Faucher, & Piarroux, 2013a, 2013b). Climate systems such as El Niño have been identified as shifting the cholera burden, based on rainfall anomalies (Moore et al., 2017). The changes in cholera burden with climate can be, at least in part, linked to behavior. Lawoyin, Ogunbodede, Olumide, and Onadeko (1999) attributed the high correlation between cholera outbreaks and climate in Ibadan city, Nigeria, to changes in behavior; during the drought people were forced to fetch water from highly contaminated streams and ponds. Cholera outbreaks, therefore, highlight urban water security inequalities specifically related to climate shocks, although their absence should not be taken to imply water security.

Several analyses have investigated the types of inequities associated with cholera. In urban areas, cholera is often more common in areas with higher population density, such as around Kumasi, Ghana (Osei & Duker, 2008), and in Dar es Salaam, Tanzania (Penrose, Caldas De Castro, Werema, & Ryan, 2010). Poverty and informal living conditions are also strong

determinants of cholera incidence (Penrose et al., 2010). While sanitation access was a determinant in cholera incidence in Dar es Salaam (Penrose et al., 2010), access to improved water supplies was not associated with cholera risk. They hypothesized that this may be due to a correlation between poverty and water access; however, other studies have highlighted the limitations of using improved water supplies to categorize access without consideration of the reliability of water supply and use.

One of the better studied urban cholera outbreaks in Africa, occurred in KwaZulu Natal, South Africa in 2000–2001. Here, the center of the outbreak was a peri-urban settlement with piped water access; however, in this case a recent policy shift to full cost recovery for drinking water had resulted in an increase in people unable to afford the piped water, instead using surface waters, and an associated increase in intermittency (McDonald et al., 2006). Here, water access indicators would be inappropriate, as would the case in the informal settlements in Addis Ababa (Ethiopia), where Adane, Mengistie, Medhin, Kloos, and Mulat (2017) demonstrated that provision of potable piped water by municipalities does not significantly reduce acute diarrhea for children under 5 due to the intermittency of water supply, contamination of water storage and poor hygienic practices.

Studies have shown that cholera, similarly to other waterborne diseases, is gendered and age dependent based on differences in exposure and vulnerability. Across the world, it is reported to affect more women, while men are more prone to other infectious diseases, mostly due to the nature of women's and men's work (Sevilimedu et al., 2016). Children are particularly vulnerable to cholera (Ali et al., 2012), as highlighted by an outbreak in Lusaka in 2003–2004 where 23% of patients were under 5, and 35% under the age of 9 (Sasaki, Suzuki, Igarashi, Tambatamba, & Mulenga, 2008). The vulnerability of children to pathogens is complex due to the fact that children have a drive to play and explore, to experience a close contact with the ground and excreta (Bartlett, 2003). Bottle-feeding requires thorough hygienic and sanitary conditions that are hard to meet, whereas breastfed babies may be vulnerable during the stage of weaning, as they first encounter the pathogens in a contaminated environment.

Limited literature was found that explores the social impacts of cholera on the urban poor and their experiences of the disease. Schaetti et al. (2013) investigated the psychosocial impacts of cholera on urban and rural populations in Zanzibar, the Democratic Republic of Congo and Kenya, with almost universal reports of interference in work/daily activities, loss of income, high costs, and sadness, anxiety and worry. The “most troubling” psychosocial impact was loss of family income associated with absence from work or income generating activities. McDonald et al. (2006) and Pauw (2003) explore the social construction of the KwaZulu-Natal cholera outbreak, focusing on the impact of cost-recovery policies and the under-design of the water supply system on access to improved water, but also consider how stigma delayed access to treatment, with sometimes fatal results.

The high correlation of cholera to climate and poverty demonstrates an acute necessity to explore the underlying factors of unequal urban water security.

## 6 | THE MULTIPLICITY OF VULNERABILITY TO CLIMATE SHOCKS

The negative impacts of climate shocks on the urban poor are compounded by the chronic water-related risks, particularly socially constructed water scarcity relating to lack of formal, affordable water provision. While there is a lack of evidence on the additional burden of drought on water insecure urban households, the evidence on water scarcity provides a rich vein to understand vulnerability.

As highlighted for cholera, poverty and informality are key aspects of vulnerability. In urban Malawi, Ghana and Kenya provide evidence that wealthier households have better access to water. Households in informal settlements and peri-urban areas are less likely to be connected to piped urban water supplies and end up spending significant amounts of time accessing water that is overpriced as it has been resold (Adams, 2018; Braimah, Obeng Nti, & Amponsah, 2018; Mudege & Zulu, 2011; see also a general overview on water reselling in Africa: Zuin et al., 2011). Intra-urban inequalities in water access are reproduced through “two-tier services which lock low-income groups into more inconvenient, poor quality services” (Jaglin, 2002, p. 231). This situation has resulted in the emergence of informal water markets that have been shown to be continually growing in East Africa (Thompson et al., 2000). Informal water vendors often operate in an unregulated context, corrupting grass roots employees to control water rationing and subsequently charging inflated prices for water access (Crow & Odaba, 2009 see also Thompson et al., 2000).

Differentiated water provision is due, in part, to (post)colonial, (post)apartheid, and poverty discrimination. Studies show that the price of urban water utility connections is prohibitively high for poor households (e.g., in Uganda Kayaga & Franceys, 2007). The case of Nairobi (Kenya) emphasizes that water supply has been directed to planned urban areas, away from informal settlements, making water more expensive for deprived households (Mudege & Zulu, 2011). Public water provision in Kampala (Uganda) was designed, under British rule in the 1930s, to serve high and middle-income households at its inception (Appelblad Fredby & Nilsson, 2013). Similarly, water planning in Nairobi (Kenya) in the 1950s centered on the ideas that,

“for domestic water supply, a normal allowance was 50 gallons per capita and day (about 220 litres per day – l/pd) for ‘non-natives’, whereas for Africans, one fifth would suffice” (Nilsson & Nyanchaga, 2008, p. 147). Similar colonial legacies of water access have been revealed in Accra (Ghana) (Bohman, 2012), Nairobi (Kenya) and Dar es Salaam (Tanzania) (Dill & Crow, 2014). The legacy of apartheid continues to today, as the water provision in Durban (South Africa) demonstrates; due to the latent assumption that Bantu households had much lower requirements for domestic water, the infrastructure and institutional arrangements in Durban made accessing water for Bantu households prohibitive resulting in use of as little as 67 L per household per day (Loftus, 2009; see also Sutherland, Scott, & Hordijk, 2015).

The nature of informal settlements requires approaches to urban water security that are appropriate for the context. Based on their study in a municipal area of Ghana, Ablo and Yekple (2018, p. 583) summarize it well: “access to adequate water supply was not necessarily dependent on the physical location of house units, but on factors such as lack of building permit, financial constraints, rental conditions, administrative procedures and ill-suited housing arrangements.” Other studies have empirical evidence along a similar line. In Abidjan, Côte d’Ivoire, a 75% subsidy was offered to low-income households for their first piped connection to the formal water supply. However, households had to provide proof of legal settlement; hence the poor living in unplanned urban areas were usually not eligible for the subsidy (Ainuson, 2010). Traditional supply-side approaches to improving water access in peri-urban areas of Dar es Salaam (Tanzania) and Cairo (Egypt) were found to be insufficient because the poor were not connected to the formal supply (Allen, Dávila, & Hofmann, 2006). Improvements in water security must consider existing structural social inequalities (Angoua, Dongo, Templeton, Zinsstag, & Bonfoh, 2018) and include the participation of local communities (Mahlanza, Ziervogel, & Scott, 2016).

Inequalities in urban water security are multidimensional and interwoven through the socioeconomic context, although only addressed in a narrow range of literature. Allen and Hofmann (2017) unpack the concept of the “urban water poor” to reveal nuances in inequalities. The life stories of two women in Dar es Salam (Tanzania) living in an unplanned settlement without piped water access show that informal and unregulated water markets can contribute to alleviating poverty for some, while contributing to chronic poverty and the inability of people to improve their lives for others. The intersecting complexities of the life stories points to the necessity to view urban water concurrently through the perspective of environment dynamics and individual life conditions. Boubacar, Pelling, Barcena, and Montandon (2017) also found that households with similar incomes had different levels of resilience to disasters in urban Niger demonstrating that household wealth is not the only important vulnerability indicator. Experiences of water scarcity vary according to age, with children being unfavorably affected. Urban child mortality rates have a stronger association with access to safe drinking water and sewerage connections than with other variables (Shi, 2000) and there are correlations between children's health, stages of childhood development and other livelihood factors (Bartlett, 2003). However, studies that disaggregate the impacts of urban water insecurity by age are few and far between and we know little in relation to how water contributes to the flow of children's lives and life courses.

Disaster risks can be partially mitigated in urban areas by improving the governance and delivery of services, for example, water services (Wanda et al., 2017). Fragmented institutional arrangements and overlapping mandates have been shown to result in poor disaster risk reduction following flooding in urban Senegal (Schaer, Thiam, & Nygaard, 2018). The mechanisms for urban water security governance which are highly complex, comprised of formal and informal institutions as well as a myriad of actors and will vary between countries and urban contexts (McGranahan & Satterthwaite, 2006; Schaer & Hanonou, 2017). Water security approaches need to be able to respond quickly to changes and hazards and vice versa, requiring integration of disaster risk reduction, planning and water supply management in urban areas. However, as Friend and Moench (2013, p. 111) remind us, there is no silver bullet for reducing the vulnerability of the urban poor: “Accommodating concerns for poverty and social justice within urban climate resilience requires us to recognise that resilient systems are not necessarily either equitable or of benefit to the poor. The evolving discourse tends to assume that resilience is an inherently positive characteristic without questioning the resilience of what and for and by whom.”

## 7 | CONCLUSION

Climate shocks and variability adversely and discriminatorily affect the urban poor. As the climate changes, the frequency and intensity of floods and droughts is broadly expected to increase across sub-Saharan Africa while urbanization will put larger populations at risk. In our review paper we have focused on urban vulnerability and poverty in sub-Saharan. Results have been fairly negative – we conclude that poor people have unequal opportunities to cope with shocks as they are deprived from access to sufficient water services and their needs are inequitably ignored. This, in turn, increases their vulnerability and impedes their pathways out of poverty. The individual and imposed vulnerability of the urban poor can be attributed to the multiple reverberating effects of floods, droughts and waterborne diseases, particularly cholera, as well as structural reasons that inhibit adaptation.

Poor settlements usually have shared aspects of water insecurity deriving from poorly constructed houses, dense settlements and the location of households in flood prone areas. Vulnerability often results from (post)colonial, (post)apartheid and poverty discrimination that is at the core of the unequal provision of formal piped networks, water quantity, and quality. Often, these legacies have been reproduced through unregulated and corrupted water markets, underserved peri-urban areas, poor governance and failing engineering solutions that ignore socioeconomic complexities and nuances. As a result, the urban poor experience a cumulative vulnerability, deriving from chronic and acute climate and water shocks that reverberate into smaller consequences, like increased food prices that, nevertheless, have dramatic effects on livelihoods. The hope and the solutions lie in building on the creative adaptation mechanisms of people, as well as in the development of participatory, interdisciplinary and integrated institutional approaches that align disaster risk reduction with urban water planning.

Our review has identified three noteworthy gaps in the peer-reviewed literature on urban sub-Saharan Africa that we encourage future research to address. First, and surprisingly, we have revealed a significant lack of evidence for the impact of drought shocks on urban water security. Second, unlike large-scale events, smaller scale flooding events that are likely to predominantly affect the poor are under researched. Both of these gaps point to the necessity of exploring the shock driven nuances that change socioeconomic dynamics, such as disruptions or difficulties in accessing usual services, goods, capitals or income-generating activities, impacted social capital, changing decision-making processes or everyday flows with consequent trade-offs.

Third, the research illuminating heterogeneous differences in relation to climate shocks between the urban poor in sub-Saharan Africa is minimal and highly sporadic. Some of the few studies we found point to the statistically significant differences between men and women or adults and children while others challenge us in our common assumptions, for instance in terms of gendered inequalities in water governance. We appeal for the research within Sub-Saharan urban programs on inequalities in water security and resilience to climate shocks to be contextual, gender sensitive and integrative of multiple correlating factors. In the context of global climate change and rapid urbanization, tackling urban water security in sub-Saharan Africa is necessary to prevent the reproduction of systemic inequalities in water access and vulnerability and meet the sustainable development goals target of safe and affordable water for all.

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## CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

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## FURTHER READING

- Douglas, I. (2017). Flooding in African cities, scales of causes, teleconnections, risks, vulnerability and impacts. *International Journal of Disaster Risk Reduction*, 26, 34–42. <https://doi.org/10.1016/j.ijdrr.2017.09.024>
- Neto, S. (2016). Water governance in an urban age. *Utilities Policy*, 43, 32–41.
- Thompson, A. A., Matamale, L., & Kharidza, S. D. (2012). Impact of climate change on Children's health in Limpopo Province, South Africa. *International Journal of Environmental Research and Public Health*, 9(3), 831–854.

## REFERENCES

- Ablo, A. D., & Yekple, E. E. (2018). Urban water stress and poor sanitation in Ghana: Perception and experiences of residents in the Ashaiman municipality. *GeoJournal*, 83(3), 583–594. <https://doi.org/10.1007/s10708-017-9787-6>
- Adams, E. A. (2018). Intra-urban inequalities in water access among households in Malawi's informal settlements: Toward pro-poor urban water policies in Africa. *Environmental Development*, 26, 34–42. <https://doi.org/10.1016/j.envdev.2018.03.004>



- Adane, M., Mengistie, B., Medhin, G., Kloos, H., & Mulat, W. (2017). Piped water supply interruptions and acute diarrhea among under-five children in Addis Ababa slums, Ethiopia: A matched case-control study. *PLoS One*, 12(1), 12. <https://doi.org/10.1371/journal.pone.0181516>
- Adelekan, I. O. (2011). Vulnerability assessment of an urban flood in Nigeria: Abeokuta flood 2007. *Natural Hazards*, 56(1), 215–231. <https://doi.org/10.1007/s11069-010-9564-z>
- Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281. <https://doi.org/10.1016/j.gloenvcha.2006.02.006>
- Adger, W. N., & Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change*, 4(3–4), 253–266.
- Agrawal, A., & Perrin, N. (2009). Climate adaptation, local institutions and rural livelihoods. In W. N. Adger, I. Lorenzoni, & K. L. O'Brien (Eds.), *Adapting to climate change: Thresholds, values, governance* (pp. 350–367). Cambridge, England: Cambridge University Press.
- Aguilera-Klink, F., Pérez-Moriana, E., & Sánchez-García, J. (2000). The social construction of scarcity. The case of water in Tenerife (Canary Islands). *Ecological Economics*, 34(2), 233–245.
- Ahmed, S. A., Diffenbaugh, N. S., & Hertel, T. W. (2009). Climate volatility deepens poverty vulnerability in developing countries. *Environmental Research Letters*, 4(3), 034004.
- Ainunson, K. G. (2010). Urban water politics and water security in disadvantaged urban communities in Ghana. *African Studies Quarterly*, 11(4), 59.
- Ajibade, I., McBean, G., & Bezner-Kerr, R. (2013). Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Global Environmental Change*, 23(6), 1714–1725. <https://doi.org/10.1016/j.gloenvcha.2013.08.009>
- Ali, M., Lopez, A. L., You, Y., Kim, Y. E., Sah, B., Maskery, B., & Clemens, J. (2012). The global burden of cholera. *Bulletin of the World Health Organization*, 90, 209–218.
- Allen, A., Dávila, J. D., & Hofmann, P. (2006). The peri-urban water poor: Citizens or consumers? *Environment and Urbanization*, 18(2), 333–351. <https://doi.org/10.1177/0956247806069608>
- Allen, A., & Hofmann, P. (2017). Relational trajectories of urban water poverty in Lima and Dar Es Salaam. In A. Lacey (Ed.), *Women, urbanization and sustainability: Practices of survival, adaptation and resistance* (pp. 93–117). London, England: Palgrave Macmillan UK.
- Amoako, C. (2018). Emerging grassroots resilience and flood responses in informal settlements in Accra, Ghana. *GeoJournal*, 83(5), 949–965.
- Angoua, E. L. E., Dongo, K., Templeton, M. R., Zinsstag, J., & Bonfoh, B. (2018). Barriers to access improved water and sanitation in poor peri-urban settlements of Abidjan, Côte D'Ivoire. *PLoS One*, 13(8), e0202928. <https://doi.org/10.1371/journal.pone.0202928>
- Appelblad Fredby, J., & Nilsson, D. (2013). From "all for some" to "some for all"? A historical geography of pro-poor water provision in Kampala. *Journal of Eastern Africa Studies*, 7(1), 40–57. <https://doi.org/10.1080/17531055.2012.708543>
- Awuor, C. B., Orindi, V. A., & Ochieng Adwera, A. (2008). Climate change and coastal cities: The case of Mombasa, Kenya. *Environment and Urbanization*, 20(1), 231–242. <https://doi.org/10.1177/0956247808089158>
- Baker, J. L. (2012). *Climate change, disaster risk and the urban poor: Cities building resilience for a changing world*. Washington DC: World Bank.
- Bakker, K. (2012). Water security: Research challenges and opportunities. *Science*, 337(6097), 914–915. <https://doi.org/10.1126/science.1226337>
- Bartlett, S. (2003). Water, sanitation and urban children: The need to go beyond "improved" provision. *Environment and Urbanization*, 15(2), 57–70.
- Biswas, A., Rahman, A., Mashreky, S., Rahman, F., & Dalal, K. (2010). Unintentional injuries and parental violence against children during flood: a study in rural Bangladesh. *Rural Remote Health*, 10(1199), 1–12.
- Bohman, A. (2012). The presence of the past: A retrospective view of the politics of urban water management in Accra, Ghana. *Water History*, 4(2), 137–154. <https://doi.org/10.1007/s12685-011-0047-2>
- Borgomeo, E., Hall, J. W., Fung, F., Watts, G., Colquhoun, K., & Lambert, C. (2014). Risk-based water resources planning: Incorporating probabilistic nonstationary climate uncertainties. *Water Resources Research*, 50(8), 6850–6873. <https://doi.org/10.1002/2014WR015558>
- Boubacar, S., Pelling, M., Barcena, A., & Montandon, R. (2017). The erosive effects of small disasters on household absorptive capacity in Niamey: A nested HEA approach. *Environment and Urbanization*, 29(1), 33–50. <https://doi.org/10.1177/0956247816685515>
- Braimah, I., Obeng Nti, K., & Amponsah, O. (2018). Poverty penalty in urban water market in Ghana. *Urban Forum*, 29(2), 147–168. <https://doi.org/10.1007/s12132-017-9328-x>
- Brooks, N. (2003). *Vulnerability, risk and adaptation: A conceptual framework* Tyndall Centre for Climate Change Research Working Paper Series (Vol. 38). Norwich, England: Tyndall Centre for Climate Change Research.
- Chang, H., Franczyk, J., & Kim, C. (2009). What is responsible for increasing flood risks? The case of Gangwon Province, Korea. *Natural Hazards*, 48(3), 339–354. <https://doi.org/10.1007/s11069-008-9266-y>
- Chitonge, H. (2014). Cities beyond networks: The status of water services for the urban poor in African cities. *African Studies*, 73(1), 58–83.
- Crivello, G., & Espinoza-Revollo, P. (2018). Care labour and temporal vulnerability in woman-child relations. In R. Rosen & K. Twamley (Eds.), *Feminism and the politics of childhood: Friends or foes?* London, England: UCL Publisher.
- Crow, B., & Odaba, E. (2009). *Scarce, costly and uncertain: water access in Kibera, Nairobi*. UC Santa Cruz: Center for Global, International and Regional Studies. Retrieved from <https://escholarship.org/uc/item/8c10s316>
- Dercon, S., Hoddinott, J., & Woldehanna, T. (2005). Shocks and consumption in 15 Ethiopian villages, 1999–2004. *Journal of African Economies*, 14(4), 559–585.
- Di Baldassarre, G., Montanari, A., Lins, H., Koutsoyiannis, D., Brandimarte, L., & Blöschl, G. (2010). Flood fatalities in Africa: From diagnosis to mitigation. *Geophysical Research Letters*, 37(22).
- Dill, B., & Crow, B. (2014). The colonial roots of inequality: Access to water in urban East Africa. *Water International*, 39(2), 187–200. <https://doi.org/10.1080/02508060.2014.894212>
- Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., McLean, L., & Campbell, J. (2008). Unjust waters: Climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, 20(1), 187–205. <https://doi.org/10.1177/0956247808089156>
- EM-DAT. (2018). *OFDA/CRED international disaster database (EM-DAT)*. Retrieved from: <http://www.em-dat.net/>
- Fatti, C. E., & Patel, Z. (2013). Perceptions and responses to urban flood risk: Implications for climate governance in the south. *Applied Geography*, 36, 13–22. <https://doi.org/10.1016/j.apgeog.2012.06.011>
- Filho, W. L., Balogun, A.-L., Ayala, D. Y., Bethurem, E. M., Murambadoro, M., Mambo, J., ... Mugabe, P. (2018). Strengthening climate change adaptation capacity in Africa—case studies from six major African cities and policy implications. *Environmental Science & Policy*, 86, 29–37.
- Foster, S., Bousquet, A., & Furey, S. (2018). Urban groundwater use in tropical Africa—a key factor in enhancing water security? *Water Policy*, 20(5), 982–994.
- Frick-Trzebitzky, F., Baghel, R., & Bruns, A. (2017). Institutional bricolage and the production of vulnerability to floods in an urbanising delta in Accra. *International Journal of Disaster Risk Reduction*, 26, 57–68. <https://doi.org/10.1016/j.ijdrr.2017.09.030>
- Friend, R., & Moench, M. (2013). What is the purpose of urban climate resilience? Implications for addressing poverty and vulnerability. *Urban Climate*, 6, 98–113.
- Füssler, H.-M. (2007). Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change*, 17(2), 155–167. <https://doi.org/10.1016/j.gloenvcha.2006.05.002>
- Gaffga, N. H., Tauxe, R. V., & Mintz, E. D. (2007). Cholera: A new homeland in Africa? *The American Journal of Tropical Medicine and Hygiene*, 77(4), 705–713.

- Geere, J.-A., & Cortobius, M. (2017). Who carries the weight of water? Fetching water in rural and urban areas and the implications for water security. *Water Alternatives*, 10(2), 513–540.
- Geraldine, T. e. (2009). *Climate change and gender justice*. Oxford, England: Oxfam GB.
- Graham, J. P., Hirai, M., & Kim, S.-S. (2016). An analysis of water collection labor among women and children in 24 sub-Saharan African countries. *PLoS One*, 11(6), e0155981. <https://doi.org/10.1371/journal.pone.0155981>
- Gribble, K. D., McGrath, M., MacLaine, A., & Lhotska, L. (2011). Supporting breastfeeding in emergencies: Protecting women's reproductive rights and maternal and infant health. *Disasters*, 35(4), 720–738.
- Güneralp, B., Güneralp, I., & Liu, Y. (2015). Changing global patterns of urban exposure to flood and drought hazards. *Global Environmental Change*, 31, 217–225. <https://doi.org/10.1016/j.gloenvcha.2015.01.002>
- Harris, L., Kleiber, D., Goldin, J., Darkwah, A., & Morinville, C. (2017). Intersections of gender and water: Comparative approaches to everyday gendered negotiations of water access in underserved areas of Accra, Ghana and Cape Town, South Africa. *Journal of Gender Studies*, 26(5), 561–582. <https://doi.org/10.1080/09589236.2016.1150819>
- Herslund, L. B., Jalayer, F., Jean-Baptiste, N., Jørgensen, G., Kabisch, S., Kombe, W., ... Printz, A. (2016). A multi-dimensional assessment of urban vulnerability to climate change in sub-Saharan Africa. *Natural Hazards*, 82(2), 149–172.
- Hoekstra, A. Y., Buurman, J., & Van Ginkel, K. C. H. (2018). Urban water security: A review. *Environmental Research Letters*, 13(5), 053002. <https://doi.org/10.1088/1748-9326/aaba52>
- IPCC. (2007). *Climate change 2007: Impacts, adaptation and vulnerability, working group II contribution to the fourth assessment report of the intergovernmental panel on climate change*. Cambridge, England: IPCC.
- IPCC (2014). Climate change 2014: Synthesis report. In Core Writing Team, R. K. Pachauri, & L. A. Meyer (Eds.), *Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change* (p. 151). Geneva, Switzerland: IPCC.
- Jaglin, S. (2002). The right to water versus cost recovery: Participation, urban water supply and the poor in sub-Saharan Africa. *Environment and Urbanization*, 14(1), 231–245. <https://doi.org/10.1177/095624780201400119>
- Jonkman, S. N., & Kelman, I. (2005). An analysis of the causes and circumstances of flood disaster deaths. *Disasters*, 29(1), 75–97.
- Kayaga, S., & Franceys, R. (2007). Costs of urban utility water connections: Excessive burden to the poor. *Utilities Policy*, 15(4), 270–277. <https://doi.org/10.1016/j.jup.2007.06.002>
- Kinuthia-Njenga, C. & Blanco, P.K. (2009). *Climate Change and Migration in Nairobi*. Report prepared for the World Bank. Retrieved from: <http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1256566800920/6505269-1268260567624/Kinuthia.pdf>
- Lawoyin, T., Ogunbodede, N., Olumide, E., & Onadeko, M. (1999). Outbreak of cholera in Ibadan, Nigeria. *European Journal of Epidemiology*, 15(4), 365–368.
- Linton, J., & Budds, J. (2014). The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water. *Geoforum*, 57(Supplement C), 170–180. <https://doi.org/10.1016/j.geoforum.2013.10.008>
- Loftus, A. (2009). Rethinking political ecologies of water. *Third World Quarterly*, 30(5), 953–968.
- Loring, P. A., Gerlach, S. C., & Huntington, H. P. (2016). The new environmental security: Linking food, water, and energy for integrative and diagnostic social-ecological research. *Journal of Agriculture, Food Systems, and Community Development*, 3(4), 55–61.
- Luker, E., & Harris, L. M. (2018). Developing new urban water supplies: Investigating motivations and barriers to groundwater use in Cape Town. *International Journal of Water Resources Development*. <https://doi.org/10.1080/07900627.2018.1509787>
- Mahlanza, L., Ziervogel, G., & Scott, D. (2016). Water, rights and poverty: An environmental justice approach to analysing water management devices in Cape Town. *Urban Forum*, 27(4), 363–382. <https://doi.org/10.1007/s12132-016-9296-6>
- Mallett, L. H., & Etzel, R. A. (2018). Flooding: What is the impact on pregnancy and child health? *Disasters*, 42(3), 432–458.
- Mcdonald, D. A., Ruiters, G., Hemson, D., Dube, B., Mbele, T., Nnadozie, R., & Ngcobo, D. (2006). *Still paying the price: Revisiting the Cholera Epidemic of 2000–2001 in South Africa Occasional Papers* (Vol. 10). Retrieved from: <http://www.municipalservicesproject.org/sites/municipalservicesproject.org/files/publications/OP10HemsonDubeMbeleNnadozieNgcoboStillPayingthePriceRevisitingtheCholeraEpidemicof2000-2001inSouthAfrica2006.pdf>
- McGranahan, G., & Satterthwaite, D. (2006). *Governance and getting the private sector to provide better water and sanitation services to the urban poor*. London, England: International Institute for Environment and Development.
- Mehta, L. (2013). *The limits to scarcity: Contesting the politics of allocation*. London: Routledge.
- Moore, S. M., Azman, A. S., Zaitchik, B. F., Mintz, E. D., Brunkard, J., Legros, D., ... Olson, D. (2017). El Niño and the shifting geography of cholera in Africa. *Proceedings of the National Academy of Sciences*, 114(17), 4436–4441.
- Mudege, N. N., & Zulu, E. M. (2011). Discourses of illegality and exclusion: When water access matters. *Global Public Health*, 6(3), 221–233. <https://doi.org/10.1080/17441692.2010.487494>
- Muller, M. (2018). Cape Town's drought: don't blame climate change. *Nature*, 559(7713), 174–176. <https://doi.org/10.1038/d41586-018-05649-1>
- Nalin, D., Levine, M., Bergquist, E., Libonati, J., Levine, R., Hoover, D., ... Hornick, R. (1978). Cholera, non-vibrio cholera, and stomach acid. *The Lancet*, 312(8095), 856–859.
- Nchito, W. S. (2007). Flood risk in unplanned settlements in Lusaka. *Environment and Urbanization*, 19(2), 539–551.
- Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). Africa. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, et al. (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1199–1265). Cambridge, England: Cambridge University Press.
- Nightingale, A. J. (2011). Bounding difference: Intersectionality and the material production of gender, caste, class and environment in Nepal. *Geoforum*, 42(2), 153–162.
- Nilsson, D., & Nyanchaga, E. R. (2008). Pipes and politics: A century of change and continuity in Kenyan urban water supply. *The Journal of Modern African Studies*, 46(1), 133–158. <https://doi.org/10.1017/S0022278X07003102>
- Osei, F. B., & Duker, A. A. (2008). Spatial and demographic patterns of Cholera in Ashanti region-Ghana. *International Journal of Health Geographics*, 7, 44. <https://doi.org/10.1186/1476-072X-7-44>
- Owusu, G., Agyei-Mensah, S., & Lund, R. (2008). Slums of hope and slums of despair: Mobility and livelihoods in Nima, Accra. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 62(3), 180–190. <https://doi.org/10.1080/00291950802335798>
- Owusu, M., Nurse-Bray, M., & Rudd, D. (2018). Gendered perception and vulnerability to climate change in urban slum communities in Accra, Ghana. *Regional Environmental Change*, 19(1), 13–25.
- Pauw, J. (2003). Press reports the politics of underdevelopment: Metered to death-how a water experiment caused riots and a cholera epidemic. *International Journal of Health Services*, 33, 819–830.
- Penrose, K., Caldas De Castro, M., Werema, J., & Ryan, E. T. (2010). Informal urban settlements and cholera risk in Dar Es Salaam, Tanzania. *PLoS Neglected Tropical Diseases*, 4(3), e631. <https://doi.org/10.1371/journal.pntd.0000631>

- Pharoah, R. (2014). Built-in risk: Linking housing concerns and flood risk in subsidized housing settlements in Cape Town, South Africa. *International Journal of Disaster Risk Science*, 5, 313–322.
- Rebaudet, S., Sudre, B., Faucher, B., & Piarroux, R. (2013a). Cholera in coastal Africa: A systematic review of its heterogeneous environmental determinants. *The Journal of Infectious Diseases*, 208(suppl\_1), S98–S106.
- Rebaudet, S., Sudre, B., Faucher, B., & Piarroux, R. (2013b). Environmental determinants of cholera outbreaks in inland Africa: A systematic review of main transmission foci and propagation routes. *The Journal of Infectious Diseases*, 208(suppl\_1), S46–S54.
- Reed, M. G., & George, C. (2011). Where in the world is environmental justice? *Progress in Human Geography*, 35(6), 835–842.
- Sadoff, C. W., Hall, J. W., Grey, D., Aerts, J. C. J. H., Ait-Kadi, M., Brown, C., ... Wiberg, D. (2015). *Securing water, sustaining growth* (Report of the GWP/OECD Task Force on Water Security and Sustainable Growth) (pp. 180). Oxford, England
- Sasaki, S., Suzuki, H., Igarashi, K., Tambatamba, B., & Mulenga, P. (2008). *Spatial analysis of risk factor of cholera outbreak for 2003–2004 in a Peri-urban area of Lusaka, Zambia*. Retrieved from: <http://www.ajtmh.org/docserver/fulltext/14761645/79/3/0790414.pdf?expires=1548063079&id=id&acname=guest&checksum=20666ACFAD80C7B567DB89DED5565083>
- Schaer, C., & Hanonou, E. K. (2017). The real governance of disaster risk Management in Peri-urban Senegal: Delivering flood response services through co-production. *Progress in Development Studies*, 17(1), 38–53. <https://doi.org/10.1177/1464993416674301>
- Schaer, C., Thiam, M. D., & Nygaard, I. (2018). Flood management in urban Senegal: An actor-oriented perspective on national and transnational adaptation interventions. *Climate and Development*, 10(3), 243–258. <https://doi.org/10.1080/17565529.2017.1291405>
- Schaer, C. (2015). Condemned to live with one's feet in water?: A case study of community based strategies and urban maladaptation in flood prone Pikine/Dakar, Senegal. *International Journal of Climate Change Strategies and Management*, 7(4), 534–551.
- Schaetti, C., Sundaram, N., Merten, S., Ali, S. M., Nyambedha, E. O., Lapika, B., ... Weiss, M. G. (2013). Comparing sociocultural features of cholera in three endemic African settings. *BMC Medicine*, 11, 206. <https://doi.org/10.1186/1741-7015-11-206>
- Sevilimedu, V., Pressley, K. D., Snook, K. R., Hogges, J. V., Politis, M. D., Sexton, J. K., ... Fung, I. C.-H. (2016). Gender-based differences in water, sanitation and hygiene-related diarrheal disease and helminthic infections: A systematic review and meta-analysis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 110(11), 637–648. <https://doi.org/10.1093/trstmh/trw080>
- Shi, A. (2000). *How access to urban potable water and sewerage connections affects child mortality* (Policy, Research Working Paper No. WPS2274). Washington, DC: World Bank.
- Simatele, D., Binns, T., & Simatele, M. (2012). Sustaining livelihoods under a changing climate: The case of urban agriculture in Lusaka, Zambia. *Journal of Environmental Planning and Management*, 55(9), 1175–1191.
- Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis*, 19(4), 689–701.
- Sultana, F. (2009). Fluid lives: Subjectivities, gender and water in rural Bangladesh. *Gender, Place and Culture*, 16(4), 427–444. <https://doi.org/10.1080/09663690903003942>
- Sutherland, C., Scott, D., & Hordijk, M. (2015). Urban water governance for more inclusive development: A reflection on the 'Waterscapes' of Durban, South Africa. *European Journal of Development Research*, 27(4), 488–504. <https://doi.org/10.1057/ejdr.2015.49>
- Swyngedouw, E. (2009). The political economy and political ecology of the hydro-social cycle. *Journal of Contemporary Water Research & Education*, 142(1), 56–60. <https://doi.org/10.1111/j.1936-704X.2009.00054.x>
- Taukeni, S., Chitiyo, G., Chitiyo, M., Asino, I., & Shipena, G. (2016). Post-traumatic stress disorder amongst children aged 8–18 affected by the 2011 northern-Namibia floods. *Jamba*, 8(2), 169. <https://doi.org/10.4102/jamba.v8i2.169>
- Thakadu, O. T., Ngwenya, B. N., Phaladze, N. A., & Bolaane, B. (2018). Sanitation and hygiene practices among primary school learners in Ngamiland district, Botswana. *Physics and Chemistry of the Earth, Parts A/B/C*, 105, 224–230. <https://doi.org/10.1016/j.pce.2018.02.006>
- Thompson, J., Porras, I. T., Wood, E., Tumwine, J. K., Mujwahuzi, M. R., Katui-Katua, M., & Johnstone, N. (2000). Waiting at the tap: Changes in urban water use in East Africa over three decades. *Environment and Urbanization*, 12(2), 37–52. <https://doi.org/10.1177/095624780001200204>
- Viljoen, M. F., & Booysen, H. J. (2006). Planning and management of flood damage control: The South African experience. *Irrigation and Drainage*, 55(SUPPL. 1), S83–S91. <https://doi.org/10.1002/ird.259>
- Wanda, E. M. M., Manda, M., Kamlomo, D., Kushe, J., Mphande, C., Kaunda, J., & Msiska, O. (2017). Governing WASH for disaster risk reduction in Karonga town, Malawi. *International Journal of Disaster Risk Reduction*, 26, 69–77. <https://doi.org/10.1016/j.ijdr.2017.09.034>
- WHO (World Health Organisation). (2018). *Weekly Epidemiological Record*. Vol. 93 No. 38 2018. World Health Organisation. <http://apps.who.int/iris/bitstream/handle/10665/274654/WER9338.pdf?ua=1>
- Williams, F. (2001). In and beyond new labour: Towards a new political ethics of care. *Critical Social Policy*, 21(4), 467–493. <https://doi.org/10.1177/026101830102100405>
- Winsemius, H. C., Jongman, B., Veldkamp, T. I., Hallegatte, S., Bangalore, M., & Ward, P. J. (2015). *Disaster risk, climate change, and poverty: Assessing the global exposure of poor people to floods and droughts*. (Policy Research Working Paper No. WPS 7480). Washington, D.C.: World Bank Group.
- Zuin, V., Ortolano, L., Alvarinho, M., Russel, K., Thebo, A., Muximpua, O., & Davis, J. (2011). Water supply services for Africa's urban poor: The role of resale. *Journal of Water and Health*, 9(4), 773–784. <https://doi.org/10.2166/wh.2011.031>

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