Urban growth and water access in sub-Saharan Africa: Progress, challenges, and emerging research directions

Stéphanie dos Santos, E. Adams, G. Neville, Y. Wada, A. de Sherbinin, E. Mullin Bernhardt, S.B. Adamo

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S. Dos Santos[1], E. A. Adams[2], G. Neville[3], Y. Wada[4,5,6], A. de Sherbinin[7], E. M. Bernhardt[8], S. B. Adamo[7]

[1]Institut de Recherche pour le Développement, Laboratoire Population-Environnement-Développement (IRD/AMU), Marseille, France. [2]Global Studies Institute, Department of Geosciences, Georgia State University, Atlanta, Georgia. [3]Department of Geography, Royal Holloway, University of London, London, United Kingdom. [4] International Institute for Applied Systems Analysis, Laxenburg, Austria. [5] Center for Climate Systems Research, Columbia University, New York, USA. [6]Center for International Earth Science Information Network, Columbia University, New York, USA. [7]UN Environment, Freshwater Ecosystems Division, Nairobi, Kenya.

Corresponding author: Stéphanie Dos Santos (Stephanie.DosSantos@ird.fr)

Abstract

For the next decade, the global water crisis remains the risk of highest concern, and ranks ahead of climate change, extreme weather events, food crises and social instability. Across the globe, nearly one in ten people is without access to an improved drinking water source. Least Developed Countries (LDCs) especially in sub-Saharan Africa (SSA) are the most affected, having disproportionately more of the global population without access to clean water than other major regions. Population growth, changing lifestyles, increasing pollution and accelerating urbanization will continue to widen the gap between the demand for water and available supply especially in urban areas, and disproportionately affect informal settlements, where the majority of SSA's urban population resides. Distribution and allocation of water will be affected by climate-induced water stresses, poor institutions, ineffective governance, and weak political will to address scarcity and mediate uncertainties in future supply. While attempts have been made by many scientists to examine different dimensions of water scarcity and urban population dynamics, there are few comprehensive reviews, especially focused on the particular situation in Sub-Saharan Africa. This paper contributes to interdisciplinary understanding of urban water supply by distilling and integrating relevant empirical knowledge on urban dynamics and water issues in SSA, focusing on progress made and associated challenges. It then points out future research directions including the need to understand how alternatives to centralized water policies may help deliver sustainable water supply to cities and informal settlements in the region.

Keywords

Urban dynamics, water scarcity, water access, governance, Sub-Saharan Africa, population

1 Introduction

For the seventh year in a row, the *Global Risk Report* places water crises in its top five global risks in terms of impact on society. In the latest report, water comes after weapons of mass destruction, extreme weather events, and ahead of major natural disasters and climate change (World Economic Forum, 2017). However, for the next decade, the water crisis remains the risk of highest concern, and ranks ahead of other risks such as climate change, extreme weather events, food crises and social instability. Absolute water scarcity is not the only issue. In sub-Saharan Africa (SSA), there are growing concerns about the distribution and allocation of water resources, water pollution, poor institutions, ineffective governance and weak political will to address growing water scarcity.

Water availability in relation to population size and growth has been the subject of a number of studies going back more than a decade (Vörösmarty et al., 2000). Even though water scarcity has historically been more acute in rural areas, emerging trends point to worsening availability and quality in urban areas due to changes in freshwater resources (caused by climatic shifts, land use change and other factors), increasing demand owing to population growth, poor sanitation and lack of water treatment facilities, as well as mismanagement (Muller, 2016; Romero-Lankao and Gnatz, 2016). In SSA, these challenges affect urban dwellers, who experience difficulties in meeting daily water needs. Moreover, agricultural and industrial sectors in the region will be confronted with increasingly limited supply of water. In light of climate change and continued growth of urban populations, there is concern that the gap between the availability, supply and demand for fresh water will widen even further in SSA, and disproportionately affect informal settlements where the majority of urban populations reside. Access to adequate improved water supplies in the expanding informal settlements in SSA is particularly worrying considering the consequences for public health, livelihoods, food production, wellbeing, and gender disparities. Municipal governments, as a result, are constantly struggling to reconcile available water supply with growing demand (Clifford-Holmes et al., 2014). Across the globe, 663 million people are officially recognized as currently being without access to an improved drinking water source (WHO/UNICEF, 2015b).

Significant progress has been made towards reducing the global population without access to improved water sources, with an estimated 91% of the total global population having access to improved water sources in 2015. However, some research shows that given the difficulties and shortcomings associated with accurately measuring the proportion of the global population without access, it is probable that the proportion thought to have access is grossly overestimated (Nganyanyuka et al., 2014; Satterthwaite, 2016; Adams 2017). In addition, conventional indicators used to estimate progress made on clean water access, especially by WHO/UNICEFs Joint Monitoring Program (JMP), conceal intra-urban, intra-rural and other pressing disparities within the water sector (WHO/UNICEF, 2015). It is therefore important to refine data collection methodologies to better understand disparities in everyday water-access and practices across different scales—especially urban and rural spaces in SSA.

The numbers are even more staggering for sanitation. The JMP estimates that as of 2015, 2.4 billion people (nearly one in three worldwide) still lacked access to safely managed sanitation (WHO/UNICEF 2015). Poorly managed sanitation facilities expose water resources to contamination. Currently, more than 80% of all wastewater worldwide is estimated to go directly back into water bodies without treatment (WWAP, 2017). There is tremendous scope for reusing wastewater as a means to improving both water availability and quality. According to UNEP (2016), declining water quality reduces suitability of water use in drinking, agricultural, and industrial sectors.

Major water policy initiatives--notably the Millennium Development Goals (MDGs) in 2000, the United Nations International Decade for Action, "Water for Life" 2005-2015, and the 2030 Agenda for Sustainable Development driving the new Sustainable Development Goals (SDGs)--remain central to the global water-sector agenda to improve access. The MDG 7 on environmental sustainability included a target to reduce by half the proportion of people without improved drinking water access, by 2015. While the global MDG target on water was achieved by 2010, five years ahead of the target deadline, SSA and Oceania were the only regions that failed to attain their goals. With few exceptions, most countries in the SSA region failed to meet both rural and urban targets under the water goal. During the "Water for Life" Decade 2005-2015, the United Nations recognized water as a human right, and explicitly stated through a resolution in 2010 that "clean drinking water and sanitation are essential to the realization of all human rights" (UN, 2010). Unlike the MDGs which subsumed water and sanitation under Goal 7 (to ensure environmental sustainability), the SDGs explicitly recognize water and sanitation as a standalone goal (number 6) that includes more expansive targets focusing on other dimensions of water such as management and governance, wastewater, and ecosystem resources (UN-Water, 2015). While attempts have been made by scientists to examine and present empirical findings on different dimensions of water scarcity and population dynamics in urban areas (e.g. de Sherbinin and Dompka, 1998), there have been no recent comprehensive reviews that synthesize findings, highlight important gaps, and provide recommendations for future research especially focused on the particular situation of urban SSA. There is a subsequent dearth of available information about strategies that can be deployed to increase water access in urban areas and informal settlements of SSA in the context of continuing population growth. Many research questions still remain at the interface of population growth and water scarcity in SSA, not least the social (socioeconomic and demographic characteristics) that are most often associated with problems of water access, and biophysical processes (e.g., climate change) threatening water availability. Thus, the core objective of this article is to synthesize knowledge on urban dynamics and water issues in SSA, in order to point out existing and emerging challenges related to water scarcity and governance, highlight progress made, and draw attention to research gaps. The paper makes an important contribution to interdisciplinary scholarship on urban water supply by distilling and integrating relevant empirical knowledge and providing important recommendations for future research directions[1].

The rest of the article is organized as follows: we first present challenges at the intersection of urban population and urbanization dynamics and water availability; then highlight major issues related to access to drinking water in urban settings including progress made in the MDGs, challenges, and limitations of conventional indicators; and discuss the role of water governance in mediating supply and demand dynamics of urban water access. The remaining sections cover scholarly gaps and emerging research directions.

2 Urban dynamics and water supply and demand in sub-Saharan Africa

2.1 An unprecedented urban growth

Population growth and climate change together present a significant challenge for urban water authorities in urban areas of developing countries in general, and of SSA in particular. Indeed, on average, Africa experienced the most rapid urbanization over the last two decades in comparison with other regions (Brikké and Vairavamoorthy, 2016). Fig. 1 presents trends in urban population as a percentage of total population and Fig. 2 highlights trends in average urbanization rates in major regions. Urbanization rates[2] in Fig 2 are based on a five year time period. Globally, urbanization rates have steadily declined. However, in absolute terms urban populations continue to increase (Fig. 1). It is projected that 2.5 billion people will be added to the world's urban population by 2050 through the combined effects of natural increase and rural-to-urban migration. In absolute terms, the increase is from 3.9 billion in 2014 to 6.3 billion by 2050 (UN/DESA, 2015). For SSA, the urban population is projected to more than triple from 346 million to 1.1 billion.

[1] This paper is an outcome from a Population-Environment Research Network (PERN) cyberseminar on "Water and Population Dynamics" (5 to 16 October 2015) in which early versions of different sections were presented and discussed.

[2] Urbanization rate is defined in this paper as the rate at which the percentage of urban population grows or declines over a specified time period (UN/DESA 2015).

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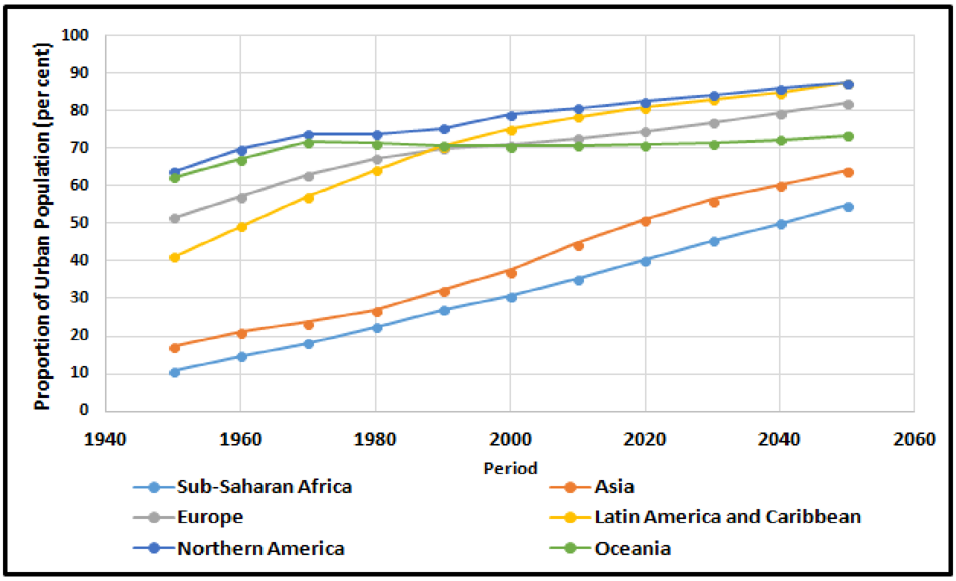

Fig. 1. Trends in Urban Population as a Percentage of Total Population in Major Regions (Data extracted from United Nations World Urbanization Report--2014 Revision

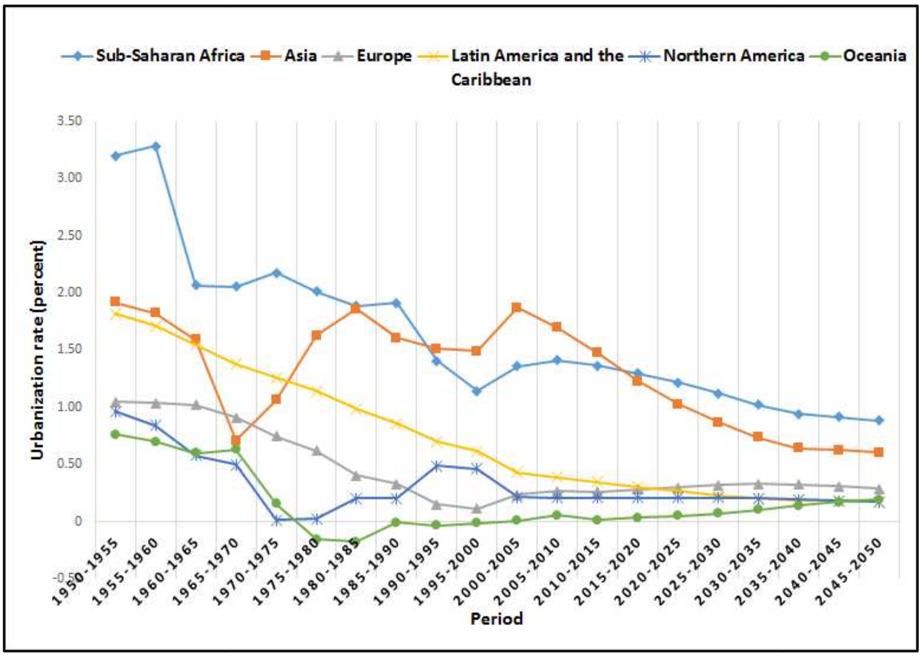

Fig. 2. Trends in Average Urbanization Rates across Regions. (Data extracted from United Nations World Urbanization Report--2014 Revision

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While urbanization in SSA generally looks set to continue at a slower rate over the next 30 years than in the past, the actual total urban population will simultaneously increase rapidly. Indeed, although fertility levels are declining in most SSA countries, especially in urban areas, unprecedented growth in the urban population will continue (UN/DESA, 2015). First, the population of SSA as a whole is forecasted to double by 2050, up to 2 billion inhabitants (UN/DESA, 2015). Second, 8 of the 10 countries with the highest urbanization rates in the world in 2014 are located in SSA, including Rwanda, Burkina Faso, Burundi, Uganda, Tanzania, Niger, Eritrea, Mali (in descending order of average annual rate of change of the urban population, 2010-2015, per cent; UN DESA, 2015). The expected population growth rate of the major SSA cities in the next 15 years will be more than 4 or 5% annually (Table 1). In 2040, the urban population will exceed the rural population in SSA, and constitute 55% of the total population of the region by 2050. During this period, SSA's urban population will certainly have tripled (UN DESA, 2015).

It is expected that this growth will be mostly absorbed by the development and outward expansion of metropolitan areas and secondary cities. Already today, urban growth in SSA cities is in large part spontaneous, occurring in informal (unplanned) settlements where access to water and other basic services is grossly inadequate. It is estimated that 62% of urban dwellers in the region live in such undeveloped areas, compared to one-third in developing countries in general. In some capital cities, informal settlements absorb the largest share of urban growth, as in Nairobi, Kenya, where 75% of urban growth occurs (UN-Habitat, 2013).

These unparalleled trends already overwhelm existing infrastructure and challenge the capacity of institutions to respond to the future water demand. Moreover, this demand will increase faster than population for several reasons, but especially due to economic growth and the emergence of a middle class whose water needs are growing. This is particularly alarming in a context of water scarcity: McDonald et al. (2011) estimate that the total number of people living in urban areas with a perennial water shortage will increase from 24 million in 2000 to 162 million by 2050 as a result. Some cities will be particularly affected by the conjunction of these two phenomena, the extremely rapid urban growth and water insecurity. Cities like Bamako (Mali), Kampala (Uganda), Lagos (Nigeria), Niamey (Niger) and Ouagadougou (Burkina Faso) are already located in areas at high risk of water stress (see Vörösmarty et al. (2010) for a global geography of incident threat to human water security), whereas they will have the highest rates of urban growth of the continent (Table 1), and even of the world (UN-DESA, 2015).

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	Population (thousands)			Average annual rate of change (percentage)	
	2000	2016	*2030*	2000-2016	*2016-2030*
Abuja (Nigeria)	833	2 586	*4 913*	7.1	*4.6*
Addis Ababa (Ethiopia)	2 377	3 316	*5 851*	2.1	*4.1*
Antananarivo (Madagascar)	1 361	2 739	*5 073*	4.4	*4.4*
Bamako (Mali)	1 142	2 651	*5 231*	5.3	*4.9*
Dar es Salam (Tanzania)	2 272	5 409	*10 760*	5.4	*4.9*
Huambo (Angola)	578	1 337	*2 537*	5.2	*4.6*
Kampala (Uganda)	1 097	2 012	*3 939*	3.8	*4.8*
Lagos (Nigeria)	7 281	13 661	*24 239*	3.9	*4.1*
Luanda (Angola)	2 591	5 737	*10 429*	5.0	*4.3*
Lusaka (Zambia)	1 073	2 285	*4 365*	4.7	*4.6*
Mogadishu (Somalie)	1 201	2 265	*4 176*	4.0	*4.4*
N'Djamena (Chad)	703	1 310	*2 347*	3.9	*4.2*
Niamey (Niger)	696	1 125	*2 363*	3.0	*5.3*
Onitsha (Nigeria)	533	1 165	*2 147*	4.9	*4.4*
Ouagadougou (Burkina Faso)	921	2 923	*5 854*	7.2	*5.0*

Table 1. Sub-Saharan African agglomerations with the estimated average annual rate of change among the highest of the continent (>4 % per year). Source : UN-DESA, 2015. NB : Figures in italic are estimations.

2.2 Challenges of concentration and spatial distribution of people

The implications of these demographic shifts on water supply extend beyond a simple matter of heightened numbers and therefore an absolute increase in volumetric demand. They also complicate spatial aspects of the urban waterscape, specifically the concentration and distribution of formal water outlets in relation to the geography of consumer demand and of the quality of supply (Brikké and Vairavamoorthy, 2016; Hopewell and Graham, 2014; Pullan et al., 2014). The result in areas with an unfavorable or fragile supply-demand balance is that the basic resource of water becomes one of the fundamental cornerstones of daily socio-political conflicts. This is the case at multiple scales ranging from governance practitioners involved in the administration of policy, as well as residents at the community level who must navigate potential water access uncertainty in order to satisfy immediate household demand.

The spatial supply-demand quandary manifests most in small towns and peri-urban areas in SSA. Small towns and peri-urban areas are themselves fundamentally heterogeneous, yet commonly share the situation of boasting both rural and urban socio-economic, environmental and institutional characteristics (Allen, 2003). They also both ordinarily experience unprecedented rates of growth, which augments the already inferior service infrastructure in such

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regions compared with the standard of the stereotypical developing city core. The strain in the supply-demand relationship becomes increasingly tested, often tipping either towards or beyond the unsustainable (Drechsel et al., 2014). So, although small towns and peri-urban areas are already home to a significant proportion of the currently unserved urban population, this spatial inequity will only intensify if such growth is met with continued underinvestment (Cardone and Fonseca, 2006).

The pervasiveness of these spatial urban water inequalities is a cause for concern. For every one large city in the developing world of between 50,000 and 200,000 residents, there are approximately ten small towns with a population of 2,000 to 50,000 (WaterAid, 2010). In addition to this numerical dominance (as an illustration, a map of the SSA settlements is presented in figure 3), Pilgrim *et al.* (2007) project a fourfold increase in the number of small towns as well as their populations in just thirty years. Peri-urban areas, meanwhile, have emerged around the vast preponderance of all types of developing metropolitan areas, which are undergoing equally rapid and intense processes of change (Allen et al., 2006b). It thus seems reasonable to suggest that small towns and peri-urban areas are representative of mainstream urban society in practice, yet they continue to be seen as curious entities that exist in between the binary urban/rural dichotomy. After all, international and institutional water policy still generally seems to group together agglomerations of all different sizes, populations and make-up under the same ‘urban’ banner.

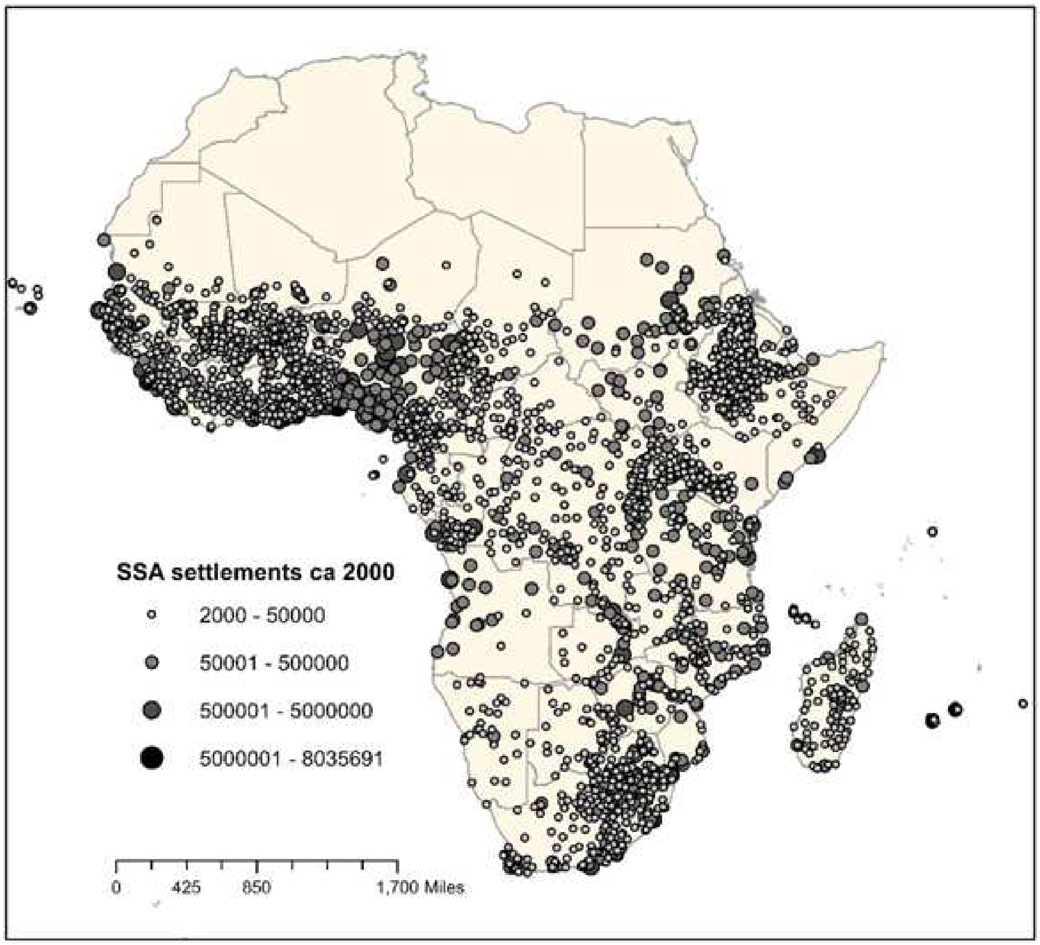

Fig. 3. Sub-Saharan Africa settlements ca 2000, by population size

Source: Center for International Earth Science Information Network - CIESIN - Columbia University, CUNY Institute for Demographic Research - CIDR, International Food Policy Research Institute - IFPRI, The World Bank, and Centro Internacional de Agricultura Tropical - CIAT. 2017. Global Rural-Urban Mapping Project, Version 1 (GRUMPv1): Settlement Points, Revision 01. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4BC3WG1. Accessed 26 April 2017.

This problematic conceptualization of space and the associated rigidity of governance are ultimately stumbling blocks to improving the quality of life in small towns and peri-urban areas. The spatial distribution of both the population and water supply needs to assume a central narrative. Context matters, and ill-informed ways of conceptualizing urban space will impede service delivery. Since even in many water-stressed regions there will be adequate water per unit of volume to serve the population, there needs to be a greater focus on the spatial distribution of supply and demand.

3 Access to water in urban settings: progress and challenges

3.1 Progress and limitations of conventional indicators

Despite significant progress on global improved-water access coverage based on the MDG targets and achievements, there is still considerable skepticism about the accuracy of the numbers put out by the Joint Monitoring Program. Over a 25-year period between 1990 and 2015,2.6 billion people gained access to improved drinking water sources (of which a significant proportion were in China). Figures from the JMP, which was tasked with measuring progress on these indicators (WHO/UNICEF, 2015), show that, in 2015, 91% of the global populations had access to improved sources of drinking water. An "improved" drinking water source, in this case, is one that, by the nature of its construction and when properly used, adequately protects the source from outside contamination, particularly fecal matter[3]. In 1990 that level stood at 76% worldwide. The number of countries between 1990 and 2015 in which less than 50% of the population had access to improved drinking water dropped from 23 countries in 1990 to three countries in 2015. These global figures, however, mask deep regional and spatial disparities. Of those globally who had access to improved drinking water as of 2015, 84% of the rural population and 96% of the global urban population used improved drinking water sources. Sub-Saharan Africa and Oceania, however, fell short of the MDG target, with coverage as of 2015 standing at 68% and 59% respectively (Table 2).

Region	Improved Sources				Piped Water on Premises				Total Improved	
	Urban		Rural		Urban		Rural			
	1990	2015	1990	2015	1990	2015	1990	2015	1990	2015
World	95	96	62	84	79	79	18	33	76	91
Sub-Saharan Africa	83	87	34	56	43	33	4	5	48	68
Northern Africa	95	95	80	90	86	92	33	78	87	93
Eastern Asia	97	98	56	93	79	88	11	56	68	96
Southern Asia	90	96	66	91	50	56	7	17	73	93
Southeastern Asia	90	95	63	85	42	51	5	17	72	90
Oceania	92	94	37	44	74	74	11	11	50	56
Latin America and Caribbean	94	97	63	84	88	94	37	68	85	95

Table 2. Trends in access to improved water sources as a percentage of total population by region
Source: WHO/UNICEF, 2015

[3] The official JMP definition of this indicator is the "percentage of the population with access to at least 20 liters of water per person per day from an "improved" source (household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collection) within one kilometer of the user's dwelling."

It is estimated that 96% of the urban population in developing countries now uses improved drinking water sources, compared with 84% of the rural population (WHO/UNICEF, 2015b). Since 1990, rural access to drinking water has improved steadily, yet urban access has stagnated or undergone only a marginal increase, including urban coverage with piped water on premises, which accounts for most of the access gained during this period (WHO/UNICEF, 2015b). There is subsequently a significant number of people living in urban areas in SSA who do not have access to improved water sources: as urban coverage increased by just 4% over the 25 year period (WHO/UNICEF, 2015b).

Nevertheless, the current urban access figure of 87% seems questionably high considering the magnitude of water insecurity in urban informal settlements and limitations of current metrics for measuring access. For instance, in Ouagadougou, the capital city of Burkina Faso, one of the poorest countries in the world, 99% of the population officially has access to an improved water source. However, if two key aspects of accessibility are taken into account (the quantity of water available in the domestic environment and the distance to the water point), the rate of water access is cut in half (Dos Santos, 2012a).

Water access in urban places is better than in rural areas of sub-Saharan Africa, where only 56% of the population currently has access to improved sources. Until recently, the majority of scientific work concerning the issue of access to water has primarily focused on rural areas (Gleitsmann et al., 2007). However, if we disaggregate the statistics and look at specific countries, we can discern that there has been no progress in access to improved sources in some urban places in the world, and the situation may have even regressed over recent years. For example, in cities in Kenya, the percentage of people with access to improved water sources fell from 92 to 82% between 1990 and 2015 (WHO/UNICEF, 2015b). The development of unserved informal settlements in Kenya is certainly one explanation of such a decline, as they house between 60 and 80% of the total urban dwellers (UN-Habitat, 2008). Similar trends can be found in Tanzania (where access to improved water sources dropped from 92 to 77% from 1990 to 2015), Zambia (where access fell from 88 to 86% over the same period) and Zimbabwe (with a drop of 100 to 97% over the same period), among others (WHO/UNICEF, 2015b).

The limitations of JMP indicators to properly capture access to improved water sources are widely documented in both urban (Satterthwaite, 2016; Smiley, 2016) and rural (Garriga and Foguet, 2013) contexts. In urban areas, problems include inaccurate measurement of access in informal neighborhoods (Nganyanyuka et al., 2014) and lack of attention to health implications (Lim et al., 2012). Intra-urban disparities in water access are more pronounced in informal and peri-urban settlements (Dagdeviren and Robertson, 2009); however, global indicators of water access fail to capture such disparities. Microscale studies are needed to better understand the major obstacles to everyday water access in informal urban settlements in SSA (Dos Santos, 2012a; Howard and Bartram, 2003; Schaefer et al., 2007). Hunter et al. (2010, p. 3) described six water supply determinants that play an effective role in maintaining good health: quality,

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quantity, access (physical distance or socioeconomic and cultural dimensions of access), reliability, cost, and ease of management. These determinants are coherent with the normative criteria defined in the human right to water (and sanitation) through a United Nations resolution, namely: availability, physical accessibility, quality, affordability and acceptability (UN, 2010). The resolution underscored that “clean drinking water and sanitation are essential to the realization of all human rights”, and called for more international commitment towards achieving this basic right.

Improvements in water access under these broad dimensions have proved effective in reducing waterborne illnesses(Esrey et al., 1991; Hunter et al., 2010), notably by helping to promote appropriate hygienic practices such as hand washing (Cairncross et al., 2010). It is also essential to look beyond main sources of supply, given that some households in SSA may use more than one water source, depending on reliability and availability. In many African cities, water cuts are a strategy for companies that provide running water to households or collective standpipes in order to control shortages. These episodes may therefore require households to switch temporarily from their principal source to an alternative source and, for example, from an improved source of water to an unimproved source and thus potentially from a regulated to an unregulated source, such as street water vendors or wells, to mitigate the impact of the cuts (Dagdeviren and Robertson, 2009). These alternative sources of water can have varying social and health impacts on users, depending on the context (Dos Santos, 2012a). The issue of reliability, or intermittent water supply, also has consequences on the quality of drinking water consumed by households (Galaitsi et al., 2016; Kumpel and Nelson, 2016).

The United Nations “2030 Agenda for Sustainable Development” takes into consideration some of the aforementioned measurement-related limitations, with renewed commitment to provide new and more reliable metrics for monitoring progress in water, sanitation, and hygiene. The ‘JMP Green Paper for SDG Monitoring of the WASH Sector’ outlines systematic efforts by the United Nations to enhance monitoring through better indicators (WHO/UNICEF, 2015a). In the current SDG goal to ensure by 2030 “availability and sustainable management of water and sanitation for all”, targets are more cognizant of weaknesses in metrics used to track MDG progress. For example, target 6.1 emphasizes the importance of “equitable access to safe and affordable drinking water for all” as well as draw attention to safely managed water sources rather than merely stating that sources be improved (WHO/UNICEF, 2016). The new focus on safely managed water sources addresses a concern many scholars have observed: that improved sources of water may not always be free of contamination or safe for consumption (Bain et al., 2014; Boateng et al., 2013; Martínez-Santos, 2017). While emphasis on safely managed water sources is important, water quality surveillance remains a major challenge for the next decades. The targets and interpretations for the new SDGs are also more detailed, focusing on equitable, safe, affordable, and suitable water access. The new targets also differentiates between no service--use of surface water, other unimproved sources, and limited service--where water sources exist but households spend considerable time (WHO/UNICEF, 2016). Social

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issues—including gender, class, and ethnicity—must be afforded greater attention in the water access research agenda at the household and community scales. In urban areas of Africa, more than half the urban population is forced to use a collective water source, usually a standpipe, a pump, or less frequently, a well (WHO/UNICEF, 2015b). When using an external source, water for household use must be collected by one or more persons from the household, who spend a large amount of time on the various steps involved to accomplish the task: traveling to the water collection point, waiting at the water source, transporting the water and storing it. This situation is in contrast with the more favorable conditions of households that have direct access to water through taps on the premises, where water collection requires no effort. Because of increasing urbanization and the development of informal settlements that do not have access to basic water services, it is important to discuss conditions of public water access for poor populations (Mitlin and Satterthwaite, 2013). In African households that collect water from an external source, the distribution of the water-fetching burden often reflects the household division of labor along gender lines (Dos Santos, 2012b). Aligned with socially-constructed gender roles, the burden of water collection and storage usually falls on women and girls. In sub-Saharan Africa, it is estimated that women and girls spend about 40 billion hours per year transporting water (UNDP, 2006). Since the 1980s, international conferences on water have called for the incorporation of gender in policies and programs relating to water. Thus, the majority of key international declarations on gender equality have insisted on the importance of water access. However, literature on the causes and consequences for women who have poor access to water focuses more on rural areas. Until recently, the literature on women and gender was mainly theoretical with only a handful giving actual estimates (Sorenson et al., 2011). Yet, it is well established that water collection tasks in SSA countries are often differentiated by gender (Graham et al., 2016). These gender inequalities are exacerbated in underdeveloped areas (UN-Habitat, 2013). For example, a recent study conducted in the informal settlements of Ouagadougou in Burkina Faso shows that females are responsible for water collection in 84% of households sampled (Dos Santos and Wayack-Pambe, 2016).This study showed that, regarding the types of water supply, male household water collectors often use standpipes and female boreholes while the latter require significant physical effort. Women's preference for this type of supply is explained both by economic factors (water at boreholes is cheaper than water at standpipes) and by distance : women, who are less likely to have motorized transport than men, prefer boreholes that are often less remote from the dwellings than the standpipes located in the formal zones. Nevertheless, this is only a case-study. Despite the strong international recognition of the importance of the subject, more studies are still needed to systematically document household gender-water relations in informal settlements and how this may reinforce inequalities in water access.

The latest JMP report demonstrates significant inequalities in water access based on wealth quintiles. The report indicates that the gap between the richest and the poorest wealth quintiles in piped water use has widened since 2012 (WHO/UNICEF, 2015b). It is worth noting that measuring access by affordability based on wealth quantiles or income is not without flaws. Recent work by Hutton (2012) demonstrates that wealth quantiles may not be sufficient to fully capture disparities in water service affordability, thus arguing for broader set of criteria that incorporates both monetary and non-monetary costs of securing water by households. Besides income/wealth quantiles, there is abundant literature on other socio-economic determinants of not only access to water (Adams et al 2016) but also the willingness to pay for improved water supply (Briscoe et al., 1990; Gulyani et al., 2005). These socioeconomic factors encompass a set of variables including education level of family members, family size, income and the household's attitude towards government policy on water) with combined effects (Mu et al., 1990; World Bank Water Demand Research Team, 1993). Zaki and Nural Amin (2009) suggest that tenure status is another factor that may predict piped water access. The improvement of living conditions would take different forms depending on the residential status: residential mobility for tenants and modification of the dwelling for owner-occupiers (van Lindert and van Westen, 1991).

In Ouagadougou, a relationship was observed between a high percentage of house-owners and dwelling units that were less well-equipped (Dos Santos and Le Grand, 2013). An explanation is that some people left the rented-house market to acquire land in the outskirts, which implies a reduction in quality and comfort of their house and less access to basic urban services and infrastructure. Taking into account residential status is even more important when access to the property is perceived as an important event in the life cycle, and especially as a form of upward mobility (Durand-Lasserve, 1986). Development, represented here by access to piped water, is neither a simple one-dimensional process nor a simple linear trajectory, as suggested by the classical theory of modernization so criticized by post development theorists (Dos Santos and Le Grand, 2013). Thus, while the new SDGs have raised the bar to call for "safe" drinking water instead of "improved", they must also capture the multifaceted nature of everyday urban life in order to achieve inclusive water progress.

3.2 The need for in-depth research in urban areas

The challenges posed by growing demand for water in urban areas and especially in informal settlements underscore the need to understand not only problems and challenges at different scales—whether they be households, communities, municipalities, or at national levels—but also intensify focus on cross-context and cross-cultural comparisons that can generate important lessons and insights for effective water policies. There is the need for systems modeling to better understand supply-demand dynamics that take into consideration diverse primary and alternative water uses at different scales, policies, and conservation efforts (Clifford-Holmes et al., 2014). Along these lines, attention needs to be directed towards more disaggregated data especially on water accessibility, socio-demographic and economic determinants of water access, and intra-urban spatial variations. Currently, the JMP report draws data from open sources such as the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys, which can be disaggregated to urban or rural scales, and sometimes to neighborhoods within urban areas. However, inequalities at sub-city scales or intra-urban spaces will require in-depth primary research to better understand determinants of access. Some of the important questions that need addressing among the scholarly community include: what individual and contextual factors shape water use, water demand, and attitudes towards water. Very few existing studies have taken a comparative approach (Mselle et al., 2013).

While socio-demographic and economic factors that influence access to water by quantity and quality have been the subject of many studies, mainly pointing to education, income, gender of household head, household size, and wealth status as important predictors of water access (Adams et al., 2016; Dos Santos and Le Grand, 2013; Dungumaro, 2007), such work has paid much less attention to intra-urban spatial variations in water access. As more aggregated exploration of water access shows that there are urban/rural disparities in access, questions remain about whether socio-economic differentials in urban settings of SSA can explain differences in access to water. This is even more important for informal settlements where one could wrongly assume that socio-economic status is fairly homogenous. Studies in Malawi and elsewhere have long highlighted that poor people in urban areas pay more for water, and are good examples of how urban differentials manifest in access (Zeleza-Manda, 2009). However, cost and affordability is only one dimension of access. More work is needed to systematically quantify if, how, and to what extent access to water in urban settings in terms of time, volume, quality, and other dimensions reflects intra-urban socio-economic differences.

In addition, there is the need for a more thorough investigation of spatial dynamics of urban housing and how this shapes access to water, including whether there are reasonable historical antecedents. A substantial body of work on access to water in post-apartheid South Africa has shown how access disparities are often rooted in historical processes of residential segregation (Smith and Hanson, 2003; Sutherland et al., 2014). However, there is limited work that has documented the historical processes behind socio-economic segregation and whether and how this may explain access to water. There are many opportunities to empirically document the relationships between historical processes such as housing in urban settings and differential access to water. In doing so, there is the need to emphasize how the peri-urban space influences access to water in the 'urban'. As documented widely, the urban and the peri-urban are often spatially indistinct in many settings in SSA (Brook and Dávila, 2000), making it difficult for municipal governments to delineate such spaces for policy purposes (Eakin et al., 2010; Simon, 2008). In-depth research on access to water in urban settings needs to pay particular attention to how the constantly and rapidly evolving rural-urban interface may have implications for access in core urban centers. The traditional rural-urban dichotomy has long been important for understanding urban-rural disparities in access, yet the limitations of this dualism cannot be overlooked in the quest to address emerging questions on urban water access. Existing statistics that resort to the urban-rural differences, including by the popular JMP, are often guilty of oversimplification.

An emerging research thread that needs further work is informality and access to water, which centers not only on everyday practices of water access in informal settlements but also how coping is negotiated at household and community levels. Existing work on peri-urban

Burkina Faso and Ghana has shown that dependence on multiple sources of water from non-state providers may offer flexibility and security (Dos Santos, 2015; Peloso and Morinville, 2014). Yet, alternative service-delivery arrangements beyond public provision by the state remains under-investigated. Emerging work highlights that chronic, intermittent water shortages in urban informal settlements lead to negative perceptions about the role of government while at the same time prompting dependence on alternative sources (Tutu and Stoler, 2016). Such emerging themes underscore the need to empirically explore every day access to water in urban informal settlements, including through the lenses of social theories (for example urban political ecology) that are useful for teasing out institutional and power relations among actors that influence who has access to water, who participates in water-decision making and governance, and who is excluded.

4 Water governance and urban planning in mediating urban water demand and supply

4.1 Trade-offs between water as an economic value and water as a common good

There are two coexisting challenges with regard to water access: first, providing access to an increasing number of urban dwellers; and secondly, addressing the maintenance of existing systems. During the International Conference on Water and the Environment, which took place in Dublin in 1992, one of the four Dublin principles outlined in *The Dublin Statement on Water and Sustainable Development*, underscored the economic value of water (see the collective book edited by Julien (Julien, 2012) for more details on the Dublin principles and a critical discussion on their implementation in Sub-Saharan Africa). Before the Dublin conference, water was seen as a public good. The famous example of the privatization of the city's municipal water supply company of Cochabamba in Bolivia in 1999 perfectly illustrated the social impact of the implementation of such a principle in a context of poverty: the private company increased the price of water by 35% on average (Castro, 2007), and the utility forbade the collection of rainwater. Due to a series of massive social protests, the concession was terminated a few months after its implementation.

The statement of the economic value of water was however modified in its application to urban areas of poorest countries: the main focus was not to give a price to the resource itself but essentially a process of commodification of the service (Jaglin, 2012). This process was generally implemented with a pricing system based on full cost-recovery and the principal of user-pay. Studies have generally proven their social negative consequences. Ménard and Clarke (2002) analyzed water supply in urban areas in Guinea-Conakry and demonstrated that the system was based on only one hypothesis: the economic rationalism of users. Hence, the system was organized to make users aware of his/her responsibilities, by omitting the other dimensions (technical, political, social and cultural). Based on an analysis of the water service in South Africa, McDonald (2002) described the various technical and political issues related to full cost-recovery paid by the final user, such as the availability of water meters each household, a system of invoicing, and sanctions in case of unpaid invoices. Successful cases of this market-based approach to water delivery are often masked by resulting increases in tariffs. A review of 39 African countries showed that private sector participation in water supply can decrease childhood diarrhea prevalence especially in urban areas (Kosec, 2014). Yet, in francophone sub-Saharan Africa, commodification of the service was generally accompanied by an increase in the tariffs that penalized the poorest (Jaglin, 2012). A 15-year review of private water participation in water services revealed no evidence to support the claim that privatization of water services is any more efficient than the public management of water (Prasad, 2006). As a result, international agencies and proponents of universal water access remain divided about the role of the private sector to extend water services at affordable prices (Adams and Halvorsen 2014).

Since the Dublin conference and the implementation of structural adjustment policies imposed on states, one of the emblematic models of commoditized water access was the private-public partnership (PPP) (see Goldman (2007) for details on what he calls the spread of the green-neoliberalism by international agencies). During the last decade this model was called into question, primarily because the approaches of international private operators have eventually proven their ineffectiveness in contexts characterized by government financial scarcity and urban poverty (Baron and Isla, 2005). There were also many negative externalities related to equity, access and health issues. For example, Deedat and Cottle (2002) studied the case in Kwazulu-Natal where the implementation of cost recovery and prepaid water meters led to a cholera outbreak. People started to use free water sources, which were polluted, to cope with their inability to pay for the rising price of the service. McClune (2004) also found that in Namibia, the PPP in the water sector ended up overwhelming health system and leading to a financial and political crisis.

In addition, the debate was not focused on the re-assessment of the value of the service, but on the question of who paid for the service. The commodification was generally followed by full cost-recovery by the sole user. However, there are four potential sources that can be used: tariffs collected from users, taxes, state participation, and international donors. In Senegal, during the last decade, household connections to the network were completely financed by international donors (Blanc and Ghesquières, 2006). This is a political choice. There are also questions about what kinds of tariffs and fiscal arrangements can be equitable and efficient. In Johannesburg, the "Lifeline service" that established the first six cubic meters of water consumed as free was determined to be unfair, as it did not take into account household size. In addition, high consumption of the richest households was privileged to support the sustainability of the service, eclipsing the issue of the sustainability of the resource itself in a context of scarcity (Blanchon, 2009).

Beyond these points of discussion, the dominant model is universalism of the network. In this case, one operator manages the service, where possible, with the consequence being inequality. Disadvantaged informal settlements typically are not connected. As a response to the absence of the service in informal neighborhoods, a multitude of alternative solutions have emerged that combine market system and community governance (Adams and Zulu, 2015; Allen

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et al., 2006a). Moreover, they are characterized by adaptation to client needs and vulnerability. In Ouagadougou, based on a pro-poor approach, new delegated management arrangements were developed in informal neighborhoods: the company in charge of the service in formal areas delegated the service of poor neighborhoods to private small-scale providers, who bought water from vendors (Dos Santos, 2015). In Kisumu slums in Kenya, delegated management of water has lowered water costs and improved revenue collection (Nzengya, 2015).

In other cities of SSA, private water vendors have emerged to fill the gaps in supply. These vendors transport water to underserved urban areas often through tanker trucks, gallons, and carts (Dagdeviren and Robertson, 2011). However, questions remain on the quality of water provided through such small scale arrangements (Kjellén and McGranahan, 2006). In Dar es Salaam and Maputo (Jaglin, 2012), private vendors sell water taken from boreholes, with no consideration to the sustainability of the resource. For now, those alternative systems are the subject of new research that examines new examples of adaptation and auto-regulation, the issue of social fragmentation and its consequences, social polarization and dissolution of urban cohesion. Those hybrids forms of governance are largely observed in informal settlements and pose questions of regulation (Baron and Bonnassieux, 2011).

The pro-poor approach could lead to increased vulnerability: in a certain context, by providing very poor households with network water connections at a low price, water providers could exacerbate their vulnerability if those households are not capable to pay the monthly bill. Also, this approach could miss some vulnerable households living in the center of the city, and not in the informal zones, which tend to be the focus of pro-poor policies. Households in precarious circumstances are not necessarily located in informal neighborhoods. In reverse, due to intra-neighborhood disparities, all households are not necessarily poor in informal settlements. There exists a middle class, which is often households that could first benefit from the pro-poor politics, due to their capabilities.

Finally, the example of the city of Durban in South Africa seems to show that within a single approach there may co-exist apparently incompatible philosophies. Indeed, Sutherland et al (2014) highlighted an original trade-off between four dominant discourses that frame the current approach adopted by the municipal office in charge of water and sanitation services (EWS) in a context of social, political, financial and environmental constraints: "water as a human right", "water as an economic good", the idea that water service provision has to be spatially differentiated, and the "experimental governance and incremental learning" (notably based on participatory knowledge production and strong interactions between the local state and its citizens). According to the authors, "the future will reveal whether the shared discourses and the integrated knowledge and praxis that have been developed and that have placed EWS on the international stage of best practice in water delivery will survive a leadership change" (p. 486). In this respect, other comprehensive and thorough case-studies are necessary in order to bring to light these new arrangements based on trade-off between approaches that are generally at odds with one another.

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4.2 Towards community-based arrangements ?

In SSA, orthodox modes of water delivery, through state-centric and primarily public approaches have failed to address growing demand for water in poor informal settlements where poverty and overcrowding continue to exacerbate water insecurity. Similar or related reasons have accounted for the failure of either largely public or privatized water systems to adequately address poor access to water in peri-urban settlements. First, the peri-urban terrain with unplanned settlements makes extension of piped water networks daunting. Second, government utility agencies and private companies often have no financial incentives to provide services given the high upfront financial and infrastructural investments, with no guarantee of cost recovery. With a lack of political will for water network expansion to peri-urban areas, private and public utility agencies tend to cherry-pick cities over rural areas, and wealthy urban areas over low-income peri-urban and unplanned neighborhoods in part due to a reductive vision of the reality assuming that the poorer are not able to pay to be connected to the water utility. Yet, poor consumers routinely pay far and above the cost of water per unit of volume from unregulated providers.

With the failure of both public and private water-supply systems to improve access for poor urban/peri-urban communities, attention has turned to alternatives involving diverse partnerships and arrangements among public, private, non-governmental organizations (NGOs), civil society organizations, and water-user committees (Gutierrez, 2007; Nzengya, 2015). However, do these approaches hold promise for addressing the growing water needs of peri-urban areas? Little is known about whether they do, and if so, what trade-offs exist for making them viable alternatives. The important questions remain whether governance institutions with communities at the helm can lead to a more sustainable water supply, what trade-offs will ensue, and what challenges will likely undermine community-based arrangements —in particular for peri-urban and informal settlements. In rural settings where most of the prior work on community-based water management have been done, sustainability is often undermined by, among other factors, weak capacity and poor management (Spaling et al., 2014) and poor finances due to low payment by rural residents (Whittington et al., 2009). These rural-based studies have generated considerable debate about whether participation and or management are required for community-based rural water systems to be sustainable. Harvey and Reed (2007), for example, argue that community participation, not management, is a precondition for sustainability. It remains to be seen whether community-based approaches will be sustainable in urban and peri-urban areas--contexts where sufficient attention has not been paid. Partnerships, with communities in the lead, while drawing technical expertise from existing utility companies, offer valuable lessons. In Kenya, recent evidence shows that a delegated management approach (DMM) to water standpipes management with communities lowered the cost of water and improved revenue collection (Nzengya, 2015). A growing international consensus seems to favor community-based over centralized public or privatized models for their benefits including participation, empowerment, ownership, and sustainability (Cleaver and Hamada, 2010).

However, actual outcomes of community-based (CBNRM) initiatives have been mixed, showing both successes and failures in rural areas, and prompting claims that it largely remains a hypothesis (Tacconi, 2007).

A study by Adams and Zulu (2015) on the drivers of poor water access in urban informal and peri-urban settlements in Lilongwe, the primate city and capital of Malawi, reveals useful insights and lessons on the potential for decentralized, community-based water governance approaches to address growing drinking water demand in urban and peri-urban settlements of least developed countries . The Malawian government promoted the formation of Water User Associations (WUAs) in 2006 under broad decentralization reforms that attempted to address poor water access in informal settlements. Malawi's particular model can best be described as community-public private partnerships (CPPPs), where a water delivery to poor urban and peri-urban areas is jointly managed by community-elected Water User Associations, para-statal water utility companies (Lilongwe and Blantyre Water Boards in the two major cities), NGOs, and city councils. Hitherto, water delivery to poor urban areas was the responsibility of the water boards, who either contracted private vendors from communities or directly supplied water. The CPPP water-delivery model in Malawi resulted in widespread mismanagement, ultimately leading to unpaid debts incurred by parastatal companies, water network disconnections, political interference, even though urban and peri-urban water demand continued to grow enormously in the face of population growth. To address the systemic mismanagement and poor access to water, CPPPs (through the formation of WUAs) emerged as a replacement for previous management models by private operators and direct management by parastatal water boards.

Malawi's attempt to find solutions embedded in participatory community governance of water and similar but rare models of community-based water delivery could be a model for other countries facing the challenge of water delivery with cost recovery. In Malawi, a broad policy context of decentralization programs formed the backbone of decentralized, community-based water systems aimed at improving access to water in poor urban and peri-urban settings. Malawi's case of water supply through a community-delegated system suggests that while such systems have prospects and opportunities for improving water supply to peri-urban and low income areas, important trade-offs ensue between water supply and social goals (such as participation, benefit sharing, empowerment etc.) often expected of community-based governance. Community-based WUAs in Malawi, generally achieved financial solvency and stability, generating enough surpluses to pay all or most of their past water debts within 3-5 years, and generating locally significant employment. However, WUA autonomy in decision making and user participation in WUA activities were low. Most users participated as paying customers rather than active WUA members. Future (peri-) urban community efforts should anticipate these tradeoffs and be flexible to a plurality of forms of participation while simultaneously seeking creative ways to enhance participation and broaden social benefits. Successful community-based approaches for peri-urban areas will require a delicate balance between water-supply and social goals.

While community-partnership arrangements for urban water delivery are not by any means a panacea, they have showed promise in the Malawi case and potential for scaling up given the right institutional environment, support for communities, and systematic efforts to address weak community capacity and poor participation--a well known achilles heel of community-based governance (Blaikie 2006; Brown 2011). The Orangi Pilot Project (OPP) in Pakistan provides a compelling example of a successful decades-long community-government partnership. Beginning in 1980 as a government-community partnership primarily to improve access to sanitation, the OPP range of programs including sanitation, low-cost housing , health and family planning program, family entrepreneurship, and capacity building through community-training institutions (Hasan 2002, Mitlin 2001; Hassan 2006). Cooperative arrangements between community organizations and public service providers through the OPP enabled communities to successfully manage chronic water shortages (Ahmed and Sohail 2003). However, as with many community-based approaches, the OPP continues to struggle with barriers including balancing cost and investment needs with affordable services, and demand for more technical capacity (Hassan 2006).

The foregoing examples from Malawi and Pakistan suggest that further research is needed on new and alternative urban water-supply arrangements, in particular focusing on the question of participation and its modalities (by studying the power relationships, the wiggle room of the various stakeholders - in particular users and local authorities, versus officials, national authorities and donors), decision-making capacities, levels of deliberation, etc. In-depth research should document how collective forms are really plural and inclusive, by exceeding the demand for participation, currently central to the discourse on development in general.

5 Conclusions: lessons and looking forward

Sub-Saharan Africa has and will continue experiencing one of the most rapid urbanization process in the world, with a urban population projected to more than triple by 2050. This unprecedented urban growth is likely to be absorbed in large part by spontaneous settlements where access to water and other basic services are already inadequate. As a consequence, unplanned urban population growth remains a serious threat to water security in cities and informal settlements of sub-Saharan Africa. Water demand is thus projected to increase by more than 100% for many countries in SSA by the end of the century (Wada and Bierkens, 2014). It is a real challenge for the sustainability of the resource itself, but also for the existing infrastructure and the capacity of institutions to deliver safe drinking water to each household, which goes hand in hand with the issue of concentration and spatial distribution of consumer demand vis a vis the quantity and quality of supply.

On the question of greater access to water for urban African populations, it was noted that progress had been made over the last 25-years from the point of view of relative figures. However, challenges still remain for the future, particularly in informal settlements where the indicators seem to underestimate an already insufficient and critical access to a safe drinking water. Context matters, of course, and ill-informed knowledge of urban dynamics, ways of conceptualizing urban space, and estimations of effective access to water will impede service delivery, which can have substantial economic, social and health consequences.

In this sense, urban planning and water governance can be instrumental in mediating urban water demand and supply and for meeting the necessarily contextual trade-offs between visions of water as an economic value and water as a common good. Thereby, an holistic urban water management approach remains critical--one that focuses not only on biophysical and engineering dimensions of water but also pays sufficient attention to water governance, including politics, financing, urban planning, infrastructure, technology transfer architecture, coastal environmental management and stakeholder involvement. All stakeholders, including households, should be involved to make urban water management sustainable. Leadership and the right political will is needed if cities are to exploit the opportunities for sustainable urban water management that brings urban development, economic and environmental benefits, and ultimately improvements to the quality of life of the urban population. It is important that city and municipal governments call on all stakeholders to cooperate. Governments should set water prices that will enable long-term investment in and maintenance of their water infrastructure, and provide incentive for more efficient use of water. However, water pricing mechanisms for efficient may not be effective for many SSA where household income levels may be extremely low. Access to funding and support from developed countries and international bodies, and coordination with other regional initiatives and policy processes are important motivations.

While there will always be a demand for country-level metrics on access to improved water sources, and these can be strengthened, there is also a need for targeted research and improved data on urban areas of all sizes so as to improve policies aimed at universal and equitable access to water. This research should not only document disparities and the facts related to access, but also identify the paths forward for expanding access to this vital resource. Above all, there is a lot of potential for new research to understand opportunities and prospects of different policies and institutional arrangements for improving urban water access. As we have demonstrated with the case of Malawi, alternatives to orthodox, centralized approaches could help advance sustainable water access in the context of growing population and urbanization in sub-Saharan Africa and more generally in developing countries. However, more case studies are needed to understand how context may shape outcomes, how social and power relations between different actors influence who has access to water in urban spaces, who is excluded, and who participates in decision making. In short, future research directions should include how alternative, syncretic, hybrid arrangements are driven by the modalities of participation.

A final critical point, which we have not directly addressed, but which should be the subject of future research, concerns the worsening water quality and water pollution that reduce the suitability of low water levels (such as in rivers, lakes and other open water bodies). Cities should promote these water resources. For water scarce regions, improving access through wastewater treatment will be key for increasing the availability of water for urban population. SDG6 aims for the delivery of safe drinking water to all inhabitants including safe distribution networks, however, cities should also ensure adequate treatment of storm and runoff water to prevent pollution of water bodies for ecosystem.

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