Universalising water and sanitation coverage in urban areas

From global targets to local realities in Dar es Salaam, and back

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Global targets such as the Sustainable Development Goals and associated monitoring play a key role in supporting efforts to move towards universal access to water and sanitation. Reflecting on Dar es Salaam, Tanzania, this paper demonstrates how global monitoring often fails to reflect and support local efforts to improve water and sanitation in low-income settlements. Locally generated water and sanitation data and perceptions of progress can reveal important realities of water and sanitation provision that global monitoring inadvertently conceals. Global targets and indicators need to be balanced with locally grounded knowledge to usefully support efforts to move towards universal access.

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The place of the local in global goals and targets

It is often said that the battle for sustainable development will be won or lost in our cities, towns and villages, and not in our international conferences. This holds *a fortiori* for achieving universal access to acceptable[1] water and sanitation, and less so for inherently global aspirations such as mitigating climate change. Acceptable reductions in greenhouse gas emissions, a centrepiece of sustainable development, involve local actions that only protect the locality taking the action when they are combined with other local actions across the globe. By way of contrast, local progress towards universal water and sanitation provision can be met by local actions alone. In other words, climate change mitigation is a global public good, while water and sanitation provision may be a global responsibility, but it is not a global public good. Water and sanitation improvements need to take account of public benefits, but these mostly play out locally, within neighbourhoods, aquifers and basins, and through upstream-downstream effects, with comparatively few global externalities. As such, while global agreement and coordination is the *sine qua non* of mitigating climate change, it must demonstrate its contribution to improving local water and sanitation conditions.

More pertinent to this paper, local perceptions are clearly relevant to assessing progress towards universal water and sanitation provision in ways they are not relevant to assessing progress on climate mitigation. For climate mitigation there needs to be a way of assessing contributions from different countries in a comparable manner, grounded in climate science; whether local people are of the opinion that it is a contribution is largely irrelevant. For water and sanitation, on the other hand, it is a potential problem if those using the water and sanitation facilities do not agree with the experts on what constitutes coverage. Indeed, it could be considered perverse for water and sanitation scientists to assess local progress towards universal coverage on the basis of technical criteria that have not at least been checked against the priorities of the intended beneficiaries. That is nevertheless what is generally done, for good reasons, bad reasons, and rather complicated and ambiguous reasons.

[1] Acceptable is used in this paper as a generic term, recognising that the minimum quality of water or sanitation provision considered acceptable varies over time and across places. Moreover, even within official target and indicators there are often contradictions. Within the Millennium Development Goals, for example, many water source technologies designated as "improved" by the indicators used in monitoring progress were at considerable risk of delivering contaminated water, and hence of not being "safe" in the sense implied in the water target (Satterthwaite, 2016). We have tried to point out such contradictions when they exist.

Summary

This paper examines the challenges of moving towards universal coverage in Dar es Salaam, the capital of Tanzania, within the context of the global targets and how progress towards them is monitored. A central claim is that while global targets and monitoring have a role, that role should not extend to guiding local improvements. For example, international indicators of coverage are unlikely to be the best to use locally, and vice versa. Moreover, both internationally and locally, there are specifically urban challenges that tend to be neglected when common indicators are used for monitoring coverage in both rural and urban settings.

Section 1 reviews the changing international efforts to target improvements in water and sanitation provision. It starts with an account of how international efforts to improve household water and sanitation shifted from a focus on the bad condition of cities of the rapidly urbanising countries of the 19th century, to a focus on the bad conditions in rural areas of the rapidly urbanising countries of the late 20th century. To a degree, this shift reflected a change in the underlying conditions. The cities of urbanising parts of the world in the 19th century faced an urban health penalty and were at the centre of the cholera and other pandemics. In contrast, the cities of the urbanising parts of the world in the late 20th century were on average healthier than their rural surrounds.

The Millennium Development Goals (MDGs), which were intended to help guide development assistance between 2000 and 2015, included coverage targets of halving the 1990 population shares without acceptable water and sanitation by 2015 (see section 2.2.). A Joint Monitoring Programme (JMP) led by WHO and UNICEF were given responsibility for monitoring progress towards these targets. Indicators of "improved" water and sanitation were designed, based primarily on technical characteristics of the facilities used by the households. These technological features were organised in "ladders", with "improved" being the step on the ladder corresponding to the minimum acceptable coverage. The results showed coverage in terms of access to water and sanitation was improving over time, but persistently lower in rural areas and poorer countries and household groups. Overall, water met the target (with 91 per cent coverage in 2015, up from 76 in 1990), while sanitation did not (with 68 per cent coverage in 2015, up from 54 in 1990).

As described in section 1.3, however, these statistics are misleading. First, water and sanitation provision is not as tangible and assessable they first appear. Determining whether households have acceptable access is not simply a matter of deciding which types of facilities are acceptable. The same facilities may be more or less acceptable depending on where they are being used. Second, the phrasing of the targets and the stated intention of the indicators implies that "improved" water and sanitation are intended to be safe, but with no direct measures of the quality of the water or observation of the final disposal of the faecal sludge, "improved" provision is not necessarily safe. Third, the pressure on international indicators to provide a basis for international comparisons means missing out on locally relevant criteria that can make the indicators more meaningful. Fourth, the narrow focus on the household is misleading, since especially for sanitation those suffering from bad sanitation are not just those whose own facilities are inadequate – improved sanitation is a local public good.

The statistics of "improved" water and sanitation are especially misleading when it comes to rural-urban comparisons. The implications of using low-cost, on-site solutions can be very different in rural and urban settings: for example, a shallow well is more likely to be contaminated in a densely settled urban location, in part because an urban concentration of urban pit latrines is more likely to create this contamination. Equally important, is comparing shares of the population with "improved" water and sanitation across rural and urban settings. This can be misleading, at least if the lower urban share is taken to reflect the absence of water and severe sanitation deficiencies. The urban elite may bring up the urban average, but there are needy rural dwellers and needy urban dwellers, none of whom are able to secure their rights to water and/or sanitation.

Looking forward to the Sustainable Development Goals, the new targets of universal water and sanitation provision by 2030 are likely to be accompanied by new core indicators, not of "improved" but of "safely managed" water and sanitation provision. Recent texts suggest that these new and more rigorous indicators will incorporate water quality tests and information on faecal sludge treatment and hygiene facilities. If so, estimates of current coverage may fall to the point that the ambitious target of universal provision looks completely unrealistic – at least in the absence

of a greatly reinvigorated international effort. Equally important, while these new indicators do potentially provide a better basis for informing local action, they sacrifice local relevance to international comparability and neglect the water and sanitation priorities and practices of the local residents. This is best understood by considering the challenges faced in specific localities, exemplified in this paper by Dar es Salaam.

The section on Dar es Salaam starts by giving some background on past water and sanitation initiatives in Tanzania since its independence (2.1). It is quite difficult to get information on water and sanitation coverage in Dar es Salaam (Section 2.2). The statistical office has been involved in implementing the survey instruments used in estimating coverage with "improved" water and sanitation for the JMP, but, for the most part, the sampling used for these surveys do not provide a basis for estimating coverage in individual cities. The most important recent exception was the 2012 census, which offers comprehensive coverage, and could in principle provide detailed statistics down to ward areas.

Section 2.3 examines water and sanitation ladders (or climbing frames) co-produced in three informal settlements in Dar es Salaam. As part of the project this paper is based on, a local NGO (the Centre for Community Initiatives or CCI) and its community-based partner (the Tanzanian Urban Poor Federation) mapped out water and sanitation facilities and then CCI facilitated a set of participatory workshops where community-based activists developed water and sanitation ladders. The types of facilities analogous to those used in the JMP ladders accounted for one of these dimensions, though they were various cross references (such as to pit latrine emptying techniques under the dimension of waste removal for sanitation). A potential attraction of such ladders is that they are sufficiently similar to the ladders being promoted internationally to facilitate engagement with authorities, but allow the local issues to be highlighted and prioritised.

Most of Dar es Salaam's residential areas, and of the low income areas in particular, have developed informally, rather than in accordance with official planning processes and regulations. As described in Section 2.4, this poses both challenges and opportunities for water and sanitation improvement. The challenges and opportunities are shown to vary between water and sanitation (partly because of the more public benefits of good sanitation) and between more central and more peripheral areas (partly because of the challenges of density for low cost sanitation and the water-related challenges of peri-urban development). Dar es Salaam's informality makes it impossible to adopt a narrowly sectoral approach to water and sanitation provision, rolling out provision through the expansion of planned areas. On the one hand it is important for both authorities and residents to accept and work with the realities of informality, at least until better formal systems can displace the more dysfunctional informal systems. On the other hand, it is also important to recognise some of the public dangers of informal development, including the potential depletion or salinisation of the groundwater resources.

While the focus of this paper is on water and sanitation coverage, in practice this cannot be divorced from issues of water resources and environmental contamination and sustainability. Section 2.5 briefly reviews these issues for Dar es Salaam. Already there is a gap between the amount of water going into the piped system and the amount of water people would use if the piped system were functioning correctly (though in principle a large share of this gap could be met by reducing water losses, assuming these losses do not represent unaccounted for water users). Both groundwater and surface water supplies are limited and the resources are vulnerable. Some people are consuming far more than the quantity the community produced ladders suggest is needed for supplies to be acceptable, but many are consuming less. Reconciling the conflicting interests among different groups and over time is difficult. Just as the use of increasing amounts of water raises water resource issues, the creation of increasing quantities of human waste raises downstream (and underground) issues of faecal sludge treatment and recycling. There are no obvious risks of conflicting interest here similar to that between universal water provision and sustainable water withdrawals, but motivating people and institutions to treat faecal sludge in a way that protects public health is difficult.

This paper concludes with a section that looks briefly at the importance of local urban information and action in meeting the global challenge of universal water and sanitation coverage. It is important to reconcile some of the tensions between internationally and locally driven efforts to achieve universal water and sanitation provision. It would be a mistake to adopt the internationally comparable indicators of coverage to drive local action in cities. The debate on global targets and indicators, and how to monitor and achieve them, should be linked with more locally grounded efforts, including, for example, the locally generated data such as water and sanitation ladders

1

International efforts to improve water and sanitation provision and the changing rural-urban politics

1.1 Background: from the urban public health movement to rural-focused targets

Water and sanitation improvements were central to the public health movements that emerged in the industrialising and unsanitary cities of the 19th century (Melosi, 2000). Life expectancy had long been lower and child mortality higher in cities (Szreter & Mooney, 1998; Woods, 2003), with polluted water and unsanitary conditions contributing to this. Urban agglomeration was economically advantageous (Glaeser, 2011; Spence, Annez, & Buckley, 2009; Williamson, 1990), but with 19th century technologies and inequalities the crowding and congestion associated with urbanisation were unhealthy.

The sanitary revolution started in 19th century English cities because there was an urban sanitation and health crisis, and a growing collective belief that something should and could be done about it, including by the government. Rural water and sanitation technologies were inappropriate in these rapidly growing cities, and urban adaptations such as cesspools and private water systems were inadequate. Sanitary science progressed over the century, and early on pointed to accumulations of faecal sludge as a leading cause of disease, though the mechanisms were poorly understood. Evidence on the sanitary conditions was gathered, including most notably Edwin Chadwick's (1842) *Report on Sanitary Condition of the Labouring Population and the Means of its Improvement*.

By the "great stink" of London's summer of 1858, created by the sewage polluting the Thames, the Times could claim that Parliament was "all but compelled to legislate upon the great London nuisance by the force

of sheer stench" (The Times, 18 June 1859, cited in Halliday, 1999). Soon thereafter, Bazalgette's ambitious improvement schemes began in earnest (Halliday, 1999). The late 19th and early 20th Century also saw the municipalisation of privately built waterworks, which recent research (Beach, Troesken, & Tynan, 2016) suggests was accompanied by an almost 20% decline in typhoid mortality (with no increase in deaths from non-waterborne causes).

The cholera pandemics that spanned the 19th century and cities across much of the world, ended up being an important driver of change, ensuring that the sanitary revolution was an international phenomenon. The fact that the disease concentrated in the unsanitary "slums" of the urban "labouring population", but also killed many of the affluent, made universal coverage the ideal. For the most part, however, it was a revolution for economically successful cities and more of a band-aid elsewhere. In lower income urban settings, where an economic commitment to universal coverage could not be realised, piped water and sanitation tended to only reach a small elite, often at subsidised tariffs. In rural areas, the changes were more incremental and somewhat delayed.

By the second half of the 20th century, when the United Nations began promoting global development, piped systems were the urban technologies of choice for both water and sanitation, with utilities that favoured institutional vehicles. Promoting such technologies suited theories of development that emphasised industrial growth and urbanisation as the motor of development. It did not, however, suit critics pointing to the failure of development to provide even basic needs for large parts of the population, and especially the rural poor (Djukanovic & Mach, 1975; Lipton, 1977). Partly as a result, when the development community began to call for international efforts to ensure everyone had adequate access to water and sanitation, the emphasis was on lower cost technologies and rural conditions.

The first call for a concerted international effort to get adequate water to everyone came at the Habitat I Conference in 1976. Sanitation was initially left out in a pattern repeated during the negotiations around the Millennium Development Goals decades later. A few years later, however, the United Nations declared the 1980s to be the 'International Drinking Water Supply and Sanitation Decade' (IDWSSD) (United Nations, 1980). The slogan of the decade was 'Water for All', but the official language was more muted, referring to substantial improvements of both water and sanitation. National governments were expected to decide with some minimal guidance what constituted safe drinking water or sanitary excreta disposal, set targets and monitor progress for both urban and rural settlements separately – with the definitions of rural and urban also determined by national governments.

The baseline (1980) estimates showed much lower coverage rates in rural than urban areas (34 as compared to 75 per cent for water and 31 as compared to 60 per cent for sanitation (World Health Organization, 1992)). Combined with the fact that over two thirds of the population lived in rural areas at the start of the decade, this seemed to argue for more attention and funding for rural water and sanitation conditions. This fit the intentions of key proponents of the IDWSSD, who reportedly wanted to shift international development assistance in the field away from conventional piped water and sewers towards lower cost and more "appropriate" technologies capable of being extended on a large scale even in rural areas (Black, 1998). In practice, an estimated 74 per cent of the financial support went to urban systems over the course of the decade (with the total split 55 to 45 per cent in favour of water) (World Health Organization, 1992, page 8). Not surprisingly, the coverage rates remained considerably higher in urban areas.

Despite the end of the IDWSSD, the 1990s saw more explicit emphasis on spending on low-cost water and sanitation technologies (through the New Delhi Statement, with its slogan of "some for all rather than more for some" (United Nations, 1990)), and explicit international targets for universal coverage (through the goals of the 1990 World Summit for Children). A key lesson taken from the decade was that low-cost technology was not sufficient without an institutional basis outside of government to spread and maintain the technology and its use (sometimes termed soft technology (Black, 1998)). On the monitoring side, the lessons included a scepticism of government statistics, particularly if these could not be validated by independent empirical estimates. Attention to achieving universal coverage was somewhat diverted by a growing interest in increasing the role of the private sector in addition to water resource management and demand management. This was countered at the start of the new millennium, however, by the Millennium Development Goals, which were intended to help guide development during the first 15 years of the new millennium, and included targets for water and sanitation coverage. As described below, they continued to frame the challenge in a way that emphasised the need to put more resources into rural water and sanitation, but in a more internationally comparable and systematic manner.

1.2 Urban and rural in the monitoring the water and sanitation targets for the MDGs

In September 2000, the United Nations General Assembly made its Millennium Declaration, with a poverty focussed set of aims, including halving the proportion of people "unable to reach or afford safe drinking water" by 2015. The Millennium Development Goals (MDGs) were developed out of this declaration. Sanitation had an even harder time securing inclusion than with the IDWSSD. Not having been mentioned in the declaration, it was initially omitted from the targets, and had to await the Johannesburg Summit of 2002 to become one. Eventually, water and sanitation coverage were twin targets under the somewhat inappropriate goal of environmental sustainability, and took the form of commitments to "halve, by the year 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation" (WHO/UNICEF, 2015a: 34).

The JMP monitoring of water and sanitation coverage for the MDGs summarised in Table 1 was based on estimates of "improved" and "unimproved" set out clearly in the ladder below (Figure 1). The core data were collected through various international household surveys, such as the Demographic and Health Surveys, which adopt modules on water and sanitation somewhat tailored to the JMP monitoring. The data had to be amenable to collection through multiple choice style questions asked of a principal household member about their household. Household survey enumerators cannot normally be expected to test water quality, monitor the treatment of faecal sludge, assess the sanitary conditions of the neighbourhood, or even observe toilets and washing facilities. As such, while when the ladder is applied, "improved" water and sanitation are taken to indicate acceptable coverage, they do not actually reflect what would normally be considered safe and sustainable water supplies or faecal sludge disposal, particularly in urban areas (Satterthwaite, 2016). They do not imply that the water or sanitation was affordable or sustainably accessible. The pressures to gather and present the ladder in simple terms also tend to hide the extent to which low income households switch amongst a set of water sources and sanitation facilities, depending on the use, the time, the season, the person in the household, or the money they have available.

Figure 1. Water and Sanitation Ladders from the 2015 MDG Assessment

	WATER	SANITATION	
IMPROVED	**Piped water on premises:** Piped household water connection located inside the user's dwelling, plot or yard	**Improved sanitation facilities:** Likely to ensure hygienic separation of human excreta from human contact. Flush/pour flush to piped sewer system, septic tank or pit; Ventilated improved pit (VIP) latrine; Pit latrine with slab; Composting toilet	IMPROVED
IMPROVED	**Other improved drinking water sources:** Public taps or standpipes; Tube wells or boreholes; Protected dug wells; Protected springs; Rainwater collection.	**Shared sanitation facilities:** Sanitation facilities of an otherwise acceptable type shared between two or more households. Only facilities that are not shared or not public are considered improved.	UNIMPROVED
UNIMPROVED	**Unimproved drinking water sources:** Unprotected dug wells; Unprotected springs; Carts with small tanks/drums; Tanker trucks; Bottled water.	**Unimproved sanitation facilities:** Do not ensure hygienic separation of human excreta from human contact. Pit latrines without a slab or platform; Hanging latrines; Bucket latrines.	UNIMPROVED
UNIMPROVED	**Surface drinking water sources:** Rivers; Dams; Lakes; Ponds; Streams; Canals; Irrigation channels.	**Open defecation:** When human faeces are disposed of in fields, forest, bushes, open bodies of water, beaches or other open spaces or disposed of with solid waste.	UNIMPROVED

Source: WHO/UNICEF (2015a)

Compared to water, sanitation coverage is low. This might seem surprising, since the wording for the water and sanitation targets that was eventually (2006) agreed on was "the proportion of the population without sustainable access to **safe** drinking water and **basic** sanitation" (Bartram et al., 2014, emphasis added). "Safe" sounds rigorously demanding, whereas "basic" does not. However somewhat similar procedures were applied to both, with only facilities with identifiably unsafe features considered unimproved, and those that ought to be safe if well managed considered improved. Moreover, there are two good reasons to expect the estimated sanitation coverage rates to be lower, the first legitimate, the second less so. The first is that sanitation coverage might actually be worse because sanitation is more of a public good than water, and people have insufficient private incentives to improve their sanitation facilities and behaviours so they do not pollute the ambient environment (McGranahan, 2015). Second, a decision was made not to treat any shared sanitation facilities as improved but not to do the same for water, reducing the sanitation estimates relative to water substantially (Cumming et.al., 2014). It is not clear whether sharing is more of a risk for sanitation however (Exley, et. al, 2015; Mara, 2016).

The patterns displayed in Table 1, with coverage increasing over time and with higher incomes, are very much what one would expect. Rural sanitation in low income economies in 1990 displays the lowest coverage, while urban water in high income economies in 2015 is the only case of 100 per cent coverage.

Even with these figures, a target of 100 per cent coverage everywhere in 2030 would look extremely ambitious and, particularly for sanitation in low income countries, which currently stands at 24 per cent in rural and 40 per cent in urban areas. The challenge would presumably look even more ambitious if the weak criteria of "improved" water and sanitation were replaced with tighter criteria ensuring that the water and faecal disposal was "safe". While these sorts of figures may be the best currently available for getting a rough idea of where, globally, the water and sanitation situation is particularly poor, they can be misleading guides to action, particularly when used locally and to distinguish between rural and urban conditions.

Table 1. Estimates of population shares with improved water and sanitation by rural and urban areas and national income groups

		WATER			SANITATION		
		URBAN	RURAL	BOTH	URBAN	RURAL	BOTH
		Improved	Improved	Improved	Improved	Improved	Improved
Country grouping	Year	(%)	(%)	(%)	(%)	(%)	(%)
Low income economies	1990	84	35	46	29	10	14
	2015	87	57	66	40	24	29
Lower middle income economies	1990	90	62	70	60	17	30
	2015	94	87	90	67	42	52
Upper middle income economies	1990	96	60	74	76	44	57
	2015	97	91	95	88	67	80
High income economies	1990	99	94	98	96	91	95
	2015	100	97	99	97	93	96
Total	**1990**	**95**	**62**	**76**	**79**	**35**	**54**
	2015	**96**	**85**	**91**	**82**	**51**	**68**

Data source: JMP (2016)

1.3 How international water and sanitation targets and urban-rural monitoring can mislead

The UNICEF/WHO Joint Monitoring Programme has made enormous progress in developing and applying international indicators of household water and sanitation (Bartram et al., 2014). It was arguably one of the more developed and successful monitoring efforts within the MDGs. Yet the results can easily mislead. Water and sanitation are less tangible than they seem, and low-cost improvements typically depend heavily on behavioural changes and not just the quality of the facilities. Moreover, privileging international comparability reduces the scope for capturing important local differences in the quality of provision. Particularly for sanitation, relying on household indicators is inherently misleading since a person's bad sanitation is often the result of neighbours' sanitation facilities and behaviours, and the number of people experiencing poor sanitation is far higher than the number with whose own facilities are poor. Especially important for this paper, whether for water or sanitation, assuming the same facilities yield the same outcomes in rural and urban settings is highly misleading, and makes urban conditions look better than they are. Moreover, it is misleading to compare rural and urban coverage rates without considering who lacks coverage in rural and urban locations and who suffers from the failure to improve conditions in rapidly growing low income urban neighbourhoods.

Overall, for reasons outlined in a bit more detail in the subsections below, the tendency has been for rural, but especially for urban, water and sanitation progress to be greatly exaggerated. Some of these tendencies are likely to be addressed as indicators are developed for the SDGs, but serious challenges will inevitably remain. It will be important to balance international monitoring with autonomous local initiatives that build on and contribute to the international monitoring. This means giving less priority to international comparability and more power to local groups, including local governments and local residents and their organisations, in both rural and urban areas.

Misplaced concreteness: What is safe water and basic sanitation anyway?

Water and sanitation provision attracts those advocating rights, targets and development assistance. Though there is considerable uncertainty in the scale and route of the impact, better provision of water and sanitation is widely believed by lay audiences and scientists alike to be important to human health and wellbeing related diseases (for recent epidemiological reviews see Ngure et al., 2014; Prüss-Ustün et al., 2014; Wolf et al., 2014). Improvements seem tangible and the conventional solutions in high-income countries – piped water and sewage systems – are relatively straightforward, if costly, to roll out. There is at least the illusion that they can be driven by investment and controlled by engineers. Perhaps more important, "safe" water and sanitation provides an attractive target, signifying progress as a technical issue that experts can monitor and politicians should in principle be able to agree on.

The language of water and sanitation reinforces various illusions about how simple and straightforward it is to provide people with drinking water and improved toilets. To a lay audience, and to officials debating water and sanitation targets internationally, it can easily seem as though the issue is just getting people clean water to drink and a basic toilet.

The term water-borne diseases can be taken to imply that such diseases are spread predominantly by drinking contaminated water. But when used by water experts, water-borne just means that the pathogens **can** be borne by water. They are often spread by other means, including person-to-person contact, food contamination, flies, or direct contact with faecal material on the ground or in waste (Brown et al., 2013). Water may be as often the culprit through its absence (the lack of water for cleaning) as through its presence (contaminated water that is ingested).

The term drinking water reinforces this confusion. To a lay reader or officials debating targets, drinking water can be taken to imply water destined for drinking. However, experts do not interpret drinking water targets as referring only to water that is drunk, and extend the term to water for cooking, washing and other domestic uses – which may be from the same source, but serve different functions, and require larger water quantities.

Alternatively, sanitation is often taken to refer to the facilities people use to dispose of their human wastes, but, particularly in urban areas, that is only the first and simplest step in ensuring that sanitary conditions in their wider sense improve. Hygiene behaviour, such as handwashing after defecation and at other critical times (Freeman et al., 2014), can make a significant difference. Moreover, the effects of different on-site sanitation systems depend heavily on local geography and on whether local groundwater is being used to provide drinking water.

In short, getting people water to drink and a basic toilet is really just the tip of the water and sanitation iceberg. Moreover, the sort of indicators summarised in Figure 1 above are not measures of the quality of provision, but rough indicators that can be very misleading. First, even where they correlate quite closely with the quality of provision, a narrow effort to improve the indicators can be counterproductive. Toilet sharing, for example, may on average be associated with lower quality sanitation, but measures that prevented sharing without increasing the number of toilets are likely to make things worse even as they improve the statistics (for more on this see section 2.2). Second, hidden inadequacies can easily bias the coverage estimates downwards. The JMP acknowledged that the indicators of "improved" supplies did not actually demonstrated that the water is safe to drink (e.g. not contaminated), or that the faecal sludge is safely disposed of – indeed this was why the weaker and more ambiguous term "improved" was coined – but somehow when the resulting statistics are presented this potentially large bias is ignored (Satterthwaite, 2016). This problem is likely to come to the fore if and when the data do become available and coverage rates go shooting down.

The problem with striving for internationally comparable standards

When compiling international statistics, international comparability is always sought, if not always achieved.[2] For water and sanitation this has been reinforced by the recent declaration of safe water and sanitation as human rights (United Nations General Assembly, 2010), which implies comparable standards. As was illustrated with Figure 1, for the MDG monitoring, comparability has been pursued by identifying simple technological characteristics that can be used to position households on water and sanitation ladders that are the same in every part of the world, and determine whether provision is deemed "improved". Two problems with this attempt at comparability are that: 1) the same technologies are not equally safe in different conditions; 2) neither safety nor the technological characteristics identified are what users prioritise when they strive to improve water and sanitation.

Piped water is probably the most comparable supply in Figure 1, but as any seasoned traveller knows, piped water systems do not always deliver safe water, and piped water is more likely to be safe in more affluent countries. Moreover, in less affluent countries the piped water may only be made available some days or parts of days, pressure may vary, and there may be regular breakdowns. The variation is not only between countries, but between and within a country's piped systems. Other water sources also vary in availability and water quality, and much the same applies to sanitation facilities. Such variations can create a systematic bias in water and sanitation statistics, one of the most important being rural and urban differences discussed below. Indeed, context matters to the point that a visitor trying to find the best water source or toilet would almost certainly do better asking the opinion of local residents directly, rather than relying on the comparable but narrow questions behind the water and sanitation ladders.

While targets and monitoring criteria such as those discussed tend to emphasise safe water and sanitation, users often emphasise other features, and may be forced to trade off a number of desirable characteristics of which safety is just one. It is revealing that even the cost-benefit analyses of improved water and sanitation published by the World Health Organization (Hutton, 2012) suggest that the most valuable benefits of improved water and sanitation supplies are not health but time related (e.g. from reduced collection times). This raises more questions about any approach to increasing water and sanitation coverage that relies so heavily on expert and official opinion that those struggling with inadequate water and sanitation contribute to neither defining the targets nor monitoring progress.

[2] There is, for example, no internationally comparable definition of urban, and international statistics on urbanisation and urban population growth (United Nations Population Division, 2015) are compiled on the basis of country-specific definitions of urban, causing some mischief (McGranahan & Satterthwaite, 2014).

The problems with focussing on household provision

People do not only need access to water and sanitation facilities at home, but also at work, school and other locations. Equally important, as should already be apparent from the discussion above, an inherent problem in the sort of ladders presented in Figure 1 is that while one can get a first indication of sanitary conditions from the quality of household facilities, the burden of bad sanitation and even to some degree poor quality water does not fall just on people without access adequate facilities. Open defecation is perhaps the most obvious example, in that the risk of open defecation is not that the defecator is exposed to their own faeces, but that others are. You can build a fine latrine, but if others don't you are still likely to be exposed to unsanitary conditions in the neighbourhood and other regularly frequented locations. The same applies if others build latrines that pollute your groundwater, flush their toilets into a local waterways, or otherwise pollute the ambient environment. Failures in sludge treatment by a utility can also expose the public to unsanitary conditions. As such, it is misleading to calculate the share of households with access to and using facilities deemed improved, and then to assume that they are being protected from bad sanitation.

The benefits of securing sufficient clean water go more clearly to those receiving it. This makes the political economy of water provision different from that for sanitation, though in practice they are closely intertwined. Also, while water may be more of a private good than sanitation, it is sufficiently shared that people are not just affected by their own household's and workplace or school's water quality. Moreover, as already noted, even the MDG target was defined in terms of sustainable as well as safe water supplies, and the sustainability of a water supply cannot be judged on the basis of the quality of the household facilities. To take sustainability seriously would mean not just looking at the downstream consequences of household water and sanitation systems, but also the upstream resources.

The problem with assuming the same water and sanitation facilities provide the same services in rural and urban locations

Even when the same technologies are used in rural and urban areas the consequences differ systematically, owing to defining rural and urban characteristics. Rural-urban is more a continuum than a clear dichotomy, and different countries define and implement their rural/urban cut-offs differently, with international statistics based on the country definitions. Generally, however, rural settlements are smaller and less dense than urban settlements (McGranahan & Satterthwaite, 2014). The concentration of larger numbers of people in smaller spaces affects the suitability of different water and sanitation technologies, and the risks and inconveniences associated with low-cost options. Thus, indicators of adequate water and sanitation should not really use the same technologies in rural and urban areas to indicate whether water or sanitation provision is acceptable. Whether from the point of view of health, convenience or dignity, the contexts are too different. In practice, with technological features the principle basis for monitoring progress, this has created a systemic bias, exaggerating urban coverage levels more than rural, albeit to an uncertain degree.

The rural-urban incomparability of technologically similar water and sanitation facilities and practices start right at the bottom of the water and sanitation ladders. Open defection is likely to be far less of a hazard in a low density rural environment than in an urban informal settlement with a density on the order of 10–100K people per square kilometre. Moving up the sanitation ladder, the same basic or improved pit latrine that provides a reasonably safe and secure sanitation when situated near a rural home, is more likely to be inconvenient and hazardous in urban areas, where emptying is typically more difficult, shifting sites regularly instead of emptying is not a serious option and, especially for women going out in the night to use a toilet, can itself be hazardous. Even with reasonable advanced technologies, the number of people likely to be affected when something goes wrong is also likely to be higher in urban areas. Turning to the water ladder, near the bottom rung, drinking from an open spring is more likely to be hazardous in urban settings, especially when sanitation is poor. The same applies to wells, even if they are protected from runoff. Chemical contaminants are also more prevalent in urban groundwater.

For both water and sanitation, safety and convenience converge towards the top end of the ladder, where functioning piped networks should be able to provide as good water and sanitation to urban as to rural dwellers. However, while space intensive on-site facilities tend to be more expensive in urban settings where land is at a premium, the networked systems towards the top of the ladders tend to be less expensive in urban settings where distances between connections are shorter and returns to scale can be secured. Thus, even ignoring rural-urban income differences and the higher economic costs, inconvenience and health risks of using simple water and sanitation technologies in urban settings, it makes sense for the piped systems to be more prevalent in urban areas.

The problem with ignoring urbanisation and the politics of intra-urban inequality when comparing rural and urban coverage

The difference in the share of urban and rural dwellers with improved water and sanitation is often taken to represent an inequality in provision (WHO/UNICEF, 2015a). This is misleading in part because, as just described, the indicators are not really comparable across rural and urban conditions. Also, while there undoubtedly are privileged groups who are more concentrated in urban areas and have better water and sanitation services, some of the most disadvantaged groups also live in urban areas, and it cannot be assumed that inequalities are improved if rural dwellers are favoured over these disadvantaged groups when it comes to improving water and sanitation conditions. It is important to consider the local context.

In the world today, poverty as well as wealth is urbanising, and even according to the dollar a day poverty line – often criticised for underestimating urban poverty (Lucci et al., 2016) – about 25 per cent of the population in poverty were urban in 2008, up from 19% in 1990 (Ravallion, 2016). Moreover, for many rural households securing and maintaining a place or at least a person in the city or town is critical to success. Urban regulations are typically designed for the wealthier residents, often pushing poorer groups including migrants into informality. Urban authorities are reluctant to plan for water and sanitation provision in rapidly expanding informal urban settlements, both because it can be extremely difficult under existing regulatory and planning frameworks, and because it requires accepting levels of population growth they would prefer to discourage. As a result, systematic urban exclusion can become entrenched (McGranahan, 2016; McGranahan et al., 2016).

In such circumstances, simplistic arguments that take the higher population shares with improved water and sanitation in urban as compared to rural areas as evidence of urban bias can actually reinforce urban exclusion. It is important to consider the people as well as the places most in need of better water and sanitation, and how people are moving and places are changing. Low levels of rural coverage are not a justification for the sort of barriers many urban poor groups face in improving their access to water and sanitation. Just as the appropriate technologies are not the same in rural and urban areas, so too the appropriate policy responses are likely to be different. Where a disproportionately high share of assistance for water and sanitation improvement is going to urban centres, this does raise questions. The funding could be going to already relatively well off, and quite possibly already relatively well served, urban dwellers. But it could also be addressing inequalities by going to some of the groups most in need.

Following a brief review of the new international water and sanitation targets and monitoring associated with the 2030 Agenda, we will try to look behind the statistics of improved and unimproved water and sanitation in Dar es Salaam, and to consider not just how important it is to consider the local specificities of the water and sanitation conditions and options, but also how rapid urban growth, urbanisation and informal expansion contribute to the challenges to improving these conditions and achieving anything that could be called universal coverage by 2030.

1.4 Moving towards the SDGs

The 2030 Agenda and its Sustainable Development Goals (SDGs) set out more ambitious and comprehensive targets for water and sanitation provision (GEMI, 2016; United Nations, 2015). The sixth SDG is dedicated to water and sanitation, and its first two targets (GEMI, 2016: 4) are currently being framed as:

Target 6.1 “By 2030, achieve universal and equitable access to safe and affordable drinking water for all”

Target 6.2 “By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations”

The shift to targeting universal coverage is itself ambitious, and indications from preliminary discussions on indicators and monitoring procedures are that the criteria for coverage are also being raised. As evident in the phrasing of the new sanitation target, hygiene is

being added, and at a minimum this is being taken to imply that toilets need to have handwashing facilities with soap and water (GEMI, 2016). For both water and sanitation, it also seems likely that an additional rung will be added to the top of the ladders, and they will require reaching this higher rung, which will be not be termed "improved", but "safely managed" (United Nations Economic and Social Council, 2016, Annex 4; WHO/UNICEF, 2015b). It is also envisaged to extend the monitoring from just households to also including schools and health.

The criteria currently proposed for estimating the share of the population with safely managed drinking water services are that the water be an "improved source located on premises, available when needed, and free from microbiological and priority chemical contamination". It is not being made clear whether or how this will be "affordable", as implied by the target, but this is far, far stricter than "improved" as used for the MDG target. Moreover it requires not only adding to the household survey data currently collected (to determine whether the water is available when needed), but also linking up the survey based estimates with estimates of the water quality from the different sources, currently assumed to come eventually from regulators and service providers.

The criteria currently proposed for safely managed sanitation services is that there be unshared and improved sanitation facilities on site with faecal wastes safely disposed of on site or transported and treated off-site, plus a handwashing facility with soap and water. Again this is a far stricter standard than "improved," not only because it requires on site facilities, but even more because it requires faecal sludge safely disposed of either on site or off, which in many countries is rarely the case. The additional monitoring evidence needed is assumed to come from in depth sanitation studies (for on-site faecal disposal) and regulators or service providers (for off-site disposal).[3]

This much more rigorous indicator of coverage reduces some of the comparability problems, though the problems of comparing rural and urban will only be overcome if the non-survey data collection is done separately for rural and urban locations. Thus, for example, it will be important to select the wells to be tested so as to capture rural and urban differences in groundwater quality. Alternatively, for sanitation it will be important to examine how key technologies perform in rural and urban settings. For some technologies, such as Arborloos, where commercially valuable trees are planted on the site of near-full latrines, the faecal sludge treatment is likely to be adequate in low density rural areas, but not in medium or high density urban areas (Mara, 2012).

There are still indications that inequality will be assessed in terms of different coverage rates among different population groups, with a recent review giving rural-urban differentials in coverage as one of the principal means of monitoring inequality (WHO/UNICEF, 2015b, page 3). This is a dubious approach, as already indicated above. The fact that wealthy people who can afford good water and sanitation tend to living in urban areas does not make it less equality-enhancing to improve the lot of poor and deprived urban dwellers. A more obvious measure of water or sanitation inequality would be the spread of households across the water or sanitation ladder (just as economic measures look at the spread in the distribution of income or wealth). This would have the added benefit of countering the tendency for binary measures of success to incentivise small shifts upwards for those already near the boundary. However, as described below for Dar es Salaam, there are many other aspects of inequality that also deserve attention.

The biggest problem for those applying this new SDG-based system of targets and indicators is likely to be that once the numbers are crunched, the target of universal coverage in 2030 may look completely unrealistic. The older indicators did not accurately reflect the ambition of the targets governments agreed to, but they did make it look as though universal coverage was within sight. Now the indicators have been recalibrated to better reflect what the targets describe as coverage, and the targets have been increased to universal coverage, a radical change in local and international water and sanitation politics is likely to be needed for the targets to have a chance of being met – of the sort the governments don't think they have signed up for.

A more practical problem is that these indicators are better suited to informing international water and sanitation sector discussions than to informing local action. They sacrifice local relevance to international comparability. They are prone to exaggerating coverage in urban as compared to rural areas, particularly for sanitation. They rely on data sets and indicators that provide a rough indicator of coverage at the national level, or perhaps wealth quintiles and rural versus urban populations, but do not provide the sort of information coverage that would allow the people without water and sanitation coverage to be located. They still neglect country or location specific water and sanitation issues, though the attempt to link up with information collected and used by local regulators and service providers is an important step forward. Perhaps most importantly, they neglect the water and sanitation priorities of the local residents and make no allowance for the need to engage with these groups, particularly those with very poor water and sanitation.

[3] There would seem to be a contradiction between this target to have all of household faecal waste disposed of safely, and another target (6.3) that only includes halving the share of wastewater that is untreated.

2

Striving for universal water and sanitation provision in Dar es Salaam

2.1 Background

Dar es Salaam City Region is the main cosmopolitan and commercial centre in Tanzania. According to the 2012 National Population Census, the City Region had a population of about 4.5 million; that is, almost double the 2002 population of 2.5 million (URT, 2016). At present, it is estimated to accommodate over 5.5 million people, and is growing at an average growth rate of 5.8 per cent per annum. This implies that the current City Region population growth rate per annum is higher than the average annual economic growth rate of about 5.5 per cent. Like several other African cities, the growth rate of Dar es Salaam City Region has declined from about 9.1 per cent per annum in the 1980s. According to the Dar es Salaam Master Plan (2012–2032), the city's population is increasing by about 226,000 people per year and is doubling every 20 years (UN, 2014). By 2025, it is projected that the City Region will accommodate over 6.2 million people (ADBG, 2014). The City Region is ranked as the 3rd and 9th fastest growing City in Africa and in the world respectively. According to the Household Budget Survey 2011/2012 about 4.1 per cent of people living in Dar es Salaam City are poor i.e. are living below the basic needs poverty line, that is they earn less than 1.25US$ per day per capita (URT, 2014).

Tanzania's first national effort to get everyone to use basic sanitation was launched by the country's first president, Julius Nyerere, as part of a set of radio campaigns labelled Mtu ni Afya (Man is Health) back in the 1970s (Hall, 1978). This was at about the same time as when global water and sanitation targets were first seriously discussed internationally. The campaign has been credited with a major shift from open defecation to the use of simple latrines, particularly in rural areas (Kumar, 2015). Such latrines do not generally qualify as acceptable sanitation in the JMP monitoring system (see Figure 1), but there are interesting parallels between this attempt to use radio fora to motivate people to organise around public health actions, including building a simple toilet for every household, and the currently widely promoted approach of Community Led Total Sanitation (CLTS) (Kar & Milward, 2011; Myers et.al., 2016). While CLTS is primarily applied in rural areas, the Tanzanian Government recently came out with a manual for its use in urban areas (Ministry of Health, 2016).

Water provision has not inspired similarly ambitious social programmes, but has received a much greater share of public investment. Water is just as bound up with hygiene and health as sanitation, but its provision has long been seen as less of a behavioural issue requiring social motivation. The water-related equivalent of the Mtu ni Afya was an ambitious plan initiated in the early 1970s to get free and safe water supplies to within 400 metres of 90 per cent of the rural population by 1990 (Kjellén, 2006, page 88; Mujwahuzi, 2002) – a coverage target later reset for 2002, by which point about half of the rural population was served. It became clear quite early on, however, that free provision was too costly, and by the 1990s village water committees were set up to manage rural water supplies with the intention that they share costs as well as responsibilities (Mujwahuzi, 2002; Rugemalila & Gibbs, 2015). Though recent decades have seen various other strategies, including attempts to engage private entrepreneurs, covering the costs of rural and even urban provision remains a serious problem. In Dar es Salaam, as in many big cities in low-income countries, a large and influential minority of households have long been in a reasonably good position to pay for acceptable services. Among the services, getting urban residents to pay for piped water tends to be easier than getting them to pay for the sanitary equivalent. Water services provide a larger direct benefit to the using household than sanitation facilities, and providing urban piped water to households is less costly than connections to sewers. But many households in Dar es Salaam cannot afford the charges associated with a piped connection, even when these charges do not cover the full costs. As public resources declined, the limited and subsidised system of household piped water connections could not even keep up with the city's population growth, whose high natural component has been amplified by rural-urban migration. Fear of stimulating yet more rural-urban migration has also undermined the incentive of local authorities to press for expanding coverage, further undermining the public water provisioning system.

The associated prevalence of informal water and sanitation provision in urban areas reflects the contemporary urban growth trends in Dar es Salaam City. The rate of growth of the informal settlements is almost twice the average urban growth rate in the City (Kombe et al., 2015). The informal settlements have been persistently growing and densifying rapidly in spite of the severe deficits of basic infrastructural services. In other words, land development trends have defied the belief that infrastructure should be a pre-condition for urban expansion. Consequently, informality as a mode of urbanisation and urban land delivery is no longer residual or transitory but an integral part of urban growth dynamics in cities facing urbanisation in poverty such as Dar es Salaam (Kombe & Kreibich, 2006). It has become the organising logic (Roy, 2005). This mode of urbanisation is influenced and at times regulated by the local actors, norms and values, but not in the manner proposed by formal planning models (Kombe et al., 2015; Kombe & Kreibich, 2001; 2006).

When economic crisis turned the financial and capacity problems of the utilities into an object of internationally imposed structural adjustment in the 1980s, the contradictions between public water coverage ambitions and political and economic realities were brought into stark relief. By the late 1990s, privatisation was being promoted as a solution, but in Dar es Salaam, as in many other instances, it failed to help in resolving these contradictions (Budds & McGranahan, 2003), and the ten year private concession granted in 2003 was withdrawn in 2005 (Dill, 2010; Pigeon, 2012; Rugemalila & Gibbs, 2015). On the other hand, small scale private involvement in water supplies has continued to grow, alongside various community-based and NGO-led alternatives. Even within the piped system, there is considerable variation in reliability and intermittency, with some household connections and standpipes far better served than others (see Kombe et al., 2015).

There is an area towards the centre of Dar es Salaam, and extending quite far north, where maps from 2011 indicate that water was meant to be supplied continuously, seven days a week (see Walnycki et al. 2017). However, a roughly equal share of the densely settled central areas and the northern periphery was rationed with water only available 1–4 days a week, and on the rapidly growing western and southern periphery it was common to ration supplies to one day a week, if water was available at all (in the periphery the mains pipes tend to follow the main transport routes). A range of different water supply systems have been developed, mostly in ad hoc ways, to supply those without connections (Kjellén, 2006). Some have been dependent on piped water, some on independent access to groundwater. Some have been public, some private, and some hybrid.

In Dar es Salaam, the Dar es Salaam Water and Sanitation Authority (DAWASA) and its subsidiary company, the Dar es Salaam Water Supply Company (DAWASCO) are the main public agencies responsible for delivery of water and sanitation services. The two public institutions are responsible for planning, mobilisation of resources, construction and operation of water and sewerage system, monitoring and overall management, including tariff setting and billing.[4] DAWASCO is largely responsible for day to day routine activities including operating and maintaining water and sewer system and providing service connections. On the other hand, DAWASA is mainly involved in building and rehabilitating the major network systems. The involvement of the five Municipalities of Dar es Salaam is limited to maintaining public health by, for instance, inspecting pit latrines (Water Aid/Share, n.d.), and constructing and monitoring boreholes in areas where DAWASA/DAWASCO supply network is lacking. Therefore, apart from these limited activities, the current governance arrangement, does not give the City Council nor its five Municipal Councils the major responsibilities or the mandates over the delivery of water supply and sanitation services in the City. This also implies that the two parastatal organisations (DAWASA and DAWASCO) are not accountable or answerable to the City/Municipal Councils, but to their governing boards and to the Ministry of Water and Irrigation. According to the Water Policy, grassroots institutions linked to local government including the Village/Mtaa Water Committees (VWCs), are responsible for the management of water supply schemes in their localities.[5]

In 2003 DAWASA set up a Community Liaison Unit to help community-managed suppliers (Allen, Hofmann, Mukherjee, & Walnycki, 2016, page 11). The Water Supply and Sanitation Act 2009 made provision for the formal establishment of Community-owned Water Supply Organisations. These organisations can take a variety of forms, and can operate water-kiosks or boreholes in informal or peri-urban settlements, initially constructed by DAWASCO or by NGOs such as WaterAid and PLAN International. The flexibility is intended to allow them to build on trust and integrity already developed through existing social networks. There are also more independent private operations, and presumably more independent community-based systems too.

Despite the very limited extent of the piped water system, Dar es Salaam has been having to draw on distant water supplies. Investments in treating and diverting water from the upper Ruvu River are ongoing and, if they go according to plan, should relieve some of the existing supply constraints (WISA, 2014). There are concerns, however, that the Wami/Ruvu basin on which Dar es Salaam depends for most of its piped water supplies will be unable to supply Dar es Salaam's growing demand without increasingly imposing sacrifices elsewhere (see Walnycki et al. 2017) Simultaneously, groundwater extraction, some by feeding into the piped system and some by independent boreholes and shallow wells, has been growing rapidly despite the dangers of aquifer depletion and salinisation. Moreover, the groundwater is increasingly polluted, particularly in the more central and heavily populated areas, with poor sanitation a major culprit. These various upstream, downstream and underground issues will be discussed briefly later in subsection 2.5, but such concerns are worth keeping in mind when considering existing water and sanitation provisioning, and how it could be changed.

2.2 Statistical accounts of household water and sanitation in Dar es Salaam

Most households in Dar es Salaam struggle to get by with a wide range of deficient water sources and sanitation facilities, some exceedingly poor quality, some exceedingly unreliable, some exceedingly expensive. This is not immediately evident from the statistics. Not that there are many statistics on water and sanitation access in Dar es Salaam. As indicated above, the surveys that feed into the global monitoring of access to water and sanitation services are not designed to provide the basis for estimating coverage rates for individual cities. And for reasons described below, the indicators based on these surveys do not really capture the key deficiencies in Dar es Salaam's household water and sanitation situation. The decadal census, last implemented in 2012, provides near complete coverage, but an even more abbreviated set of household water and sanitation options.

[4] Tariff set by DAWASA/DAWASCO for water and sanitation services are regulated by EWURA – Energy, Water and Utilities Regulatory Authority. EWURA is also responsible for monitoring the services delivered by DAWASCO/DAWASA. On the other hand, the National Environmental Management Council (NEMC) is responsible for environmental monitoring (Water Aid/Share, n.d.).
[5] LGAs are responsible for facilitating the establishment of water committees and water users groups. By the end of 2013, there were about 241 Village and Water users groups in the country (URT, 2014).

In this section we reflect on the official water and sanitation statistics that are readily available, considering both their limitations (how they can be supplemented with other quantitative and qualitative information is briefly discussed in a later section). This is intended to build up to the following sub-section which is on community-based water and sanitation ladders, and a further sub-section on the struggle for improved water and sanitation in Dar es Salaam's informal settlements. While the principal focus is on the conditions for Dar es Salaam's households, we are also trying to set the groundwork for recommendations on ways to improve water and sanitation monitoring, both locally and internationally. For this purpose the initial discussions of the Tables summarise not just water and sanitation conditions, but some the monitoring challenges they reflect or pose.

Water

The information from the surveys in Tanzania that inform the international monitoring of water and sanitation coverage do not provide statistics for Dar es Salaam specifically, but for all mainland urban settlements combined. As illustrated in Table 2, the 2010 Demographic and Health Survey (NBS Tanzania & ICF Macro, 2011) estimated that in 2010, 80 per cent of urban and 48 per cent of rural households in mainland Tanzania had access to improved water supplies.[6] The collection times, not accounted for in these figures, appear to be longer in rural areas, whereas the share of urban households boiling the water before drinking is higher in urban areas. These findings seem to confirm the conventional wisdom that water deficiencies are much more serious in rural areas (with longer collection times). They could reflect that urban households, despite better supplies, take more measures to protect themselves (such as through boiling the water). This interpretation may be wrong, however. The improved water facilities include protected wells, which, judging from the questions, includes all boreholes and all shallow wells that have a cover. But particularly in urban settings, the danger of contamination is not just water coming down the mouth of the well, but already contaminated groundwater ((Walraevens et al., 2015). Moreover, the tendency to boil water could reflect a poorer quality of the water, and not just more resources and better hygiene practices among urban populations.

Table 3 provides the latest JMP estimates of urban coverage with 'improved' water sources in Tanzania between 1990 and 2015, and shows a rapid decline in coverage (as compared to rural areas, not shown, where coverage is constant at 45 per cent). These figures are not directly comparable with those in Table 2, since, while Table 2 is taken directly from a survey, Table 3 is based on a linear regression applied to a set of different survey results, some of which may have been adjusted through various rules of thumb. Also, while statistically the results show that coverage has been falling, the fact that it has been falling so steadily since 1990 is an artefact of the technique: coverage is the dependent variable and, since the relationship between time and coverage is assumed to be linear, every five years sees the same (roughly 3%) decline in coverage. A more detailed look at the individual survey results shows a descending scatter of coverage estimates, with lines showing a steady 3 per cent decline as a reasonable

Table 2. Selected Water Access Statistics for Urban and Rural Households in Mainland Tanzania 2010 from DHS Survey

	WATER		
	URBAN	RURAL	TOTAL
	(%)	(%)	(%)
Improved water facilities	**80**	**48**	**56**
Collection time > 30 minutes	26	52	45
Boil water before drinking	47	24	30

Source: NBS Tanzania, & ICF Macro. (2011).

[6] The notes to the table state that households using bottled water as a drinking water source are considered to have an unimproved or improved source depending on the source of water they use for cooking and washing, as the quality of the bottled water isn't known. This is an odd statement, inasmuch as the quality of the sources ascribed as improved is not known either. It is doubly odd since the questionnaire never asks about the water source for cooking and washing. On the other hand, it seems quite plausible that some households did not respond that their main drinking water source was bottled water, even when they drank mainly bottled water, assuming that the question was really "what is your main source of water?" or "what is your main source of drinkable water?"

Table 3. JMP Estimates of Urban Water Coverage in Urban Tanzania 1990-2015

YEAR	TOTAL IMPROVED	PIPED ONTO PREMISES	OTHER IMPROVED	OTHER UNIMPROVED	SURFACE WATER
1990	92%	31%	61%	5%	3%
1995	89%	30%	59%	8%	3%
2000	86%	29%	57%	11%	3%
2005	83%	29%	54%	14%	3%
2010	80%	28%	52%	17%	3%
2015	77%	28%	49%	20%	3%

Source: JMP (2016)

Table 4. Main Sources of Drinking Water in Dar es Salaam from 2012 Census

Piped Water into dwelling	20.1
Piped Water to yard/plot	12.9
Public tap/ standpipe	18.8
Tube well/ borehole	18.9
Protected dug well	7.6
Unprotected dug well	4.2
Cart with small tank/drum	7.0
Tanker truck	8.4
Bottled water	1.2
Other	0.7
Total	100.0

Source: United Republic of Tanzania. (2015b).

Note: Sources may not add to exactly 100 per cent due to rounding.

estimate. The DHS 2010 survey happening to be on the line, but the DHS 2005 survey was well below the line at 78 per cent (JMP 2015). Such results are useful for making international comparisons, since the same techniques are applied in all countries, but they are not a good basis for monitoring change in urban Tanzania, let alone Dar es Salaam.

The census-based estimates for Dar es Salaam in 2012 provided in Table 4 are roughly in line with the all-mainland-urban estimates in the previous two tables. The first five sources are conventionally defined as improved, and add up to 78 per cent. Water from tanker trucks was treated as unimproved in the DHS survey for Table 2 and its positioning suggests it is also not considered improved in the census.

There are other estimates for water coverage within a year of the census, and revealingly they differ considerably from the census estimates. A statistical socioeconomic profile of Dar es Salaam from the Ministry of Statistics estimated that the percentage served with clean water increased from 47.0 in 2010 to 51.7 per cent in 2013, based on estimates from Municipal Water Engineers (United Republic of Tanzania, 2014, page 157). This implies far lower coverage, if clean water supplies are interpreted as meaning acceptable water supplies, but they could be excluding all wells. On the other hand, a sample survey

principally designed to monitor household budgets also collected information on water and sanitation in 2011/12 and came up with a similar typology but different estimates (United Republic of Tanzania, 2015). Unimproved sources were only estimated as 8.3 per cent all together, while for the census it was over 30 per cent.[7]

Being based on a census targeting all households, the data on which Table 4 is based are potentially much more useful for informing local water improvement. The table is for Dar es Salaam, which was not possible with the DHS survey, but with the cooperation of the National Bureau of Statistics it would be possible to present the census statistics for every ward or even sub-ward of the city. This is the sort of information that DAWASA and DAWASCO could use in their planning and operations, as could INGOs like WaterAid. Even ward leaders, local NGOs and grassroots organisations (e.g. the Tanzania Urban Poor Federation) could use the local information were it provided in a timely fashion with local detail – though privacy dictates against providing data at sufficient resolution that specific households can be identified.

There are various potential problems with this classification, particularly if the source is meant to indicate the quality of household water provision:

1. The classification does not include any information on water contamination, although the evidence gathered by CCI as part of the Cities and Basins project suggests that even for municipal piped water and boreholes tapping sweet water, faecal contamination is common.
2. The term "main source of drinking water" is itself somewhat ambiguous: it could be interpreted to mean the main source of drinkable water, the main source of water for household uses (as opposed to, for example, irrigation water), or the source that supplies most of the water the households actually drink.
3. The sources are not mutually exclusive, though they are presented as such. The first three are presumably meant to be from the centralised piped water system, and the rest from different and distinct sources. But in practice, water from the fourth source, tube wells, can be piped into some households (source 1), may provide a yard tap for others (source 2) and may also supply public taps (source 3). Various other hybrids are possible.
4. The quality of the water supply varies greatly for each source. Even piped water supplies vary in regularity, expense (especially if the connection costs are included), and contamination level. Standpipes vary in distance and queuing and filling time. Borehole water varies in salinity, other contaminants, expense, accessibility, daily regularity and seasonal availability. And so on. While the improved sources may on average have fewer and lesser deficiencies than the sources defined as unimproved, in a city like Dar es Salaam they all too often fall below what anyone would want to call acceptable.
5. Households often use more than one source of water. This may relate to quality and price, as when saline water from a shallow well is used for washing, and more expensive vendor water is used for food preparation and drinking. It may relate to availability, such as when piped water is interrupted, wells dry up, deliveries fail to arrive, or electric water pumps fail. Or it may relate to income, such as when a household stops purchasing good quality water due to an earner getting sick.
6. Households and individuals vary in their ability to store and collect water, their water needs, and their hygiene behaviours, affecting the acceptability and safety of the same water sources.

These dynamics in access to water are generally not clearly understood, primarily because of over-generalisation. In short, while the conventional classification of sources may serve international comparability, as various researchers have already pointed, out such classifications do not do justice to the messy realities of water provision in a city like Dar es Salaam (Dill & Crow, 2014; Kjellén, 2006; Nganyanyuka, et al., 2014; Smiley, 2013, 2016). None of the named sources delivers a clearly defined service to all its users, and most residents are in a constant struggle to trade off the problems of expense, water quality, and convenience, switching sources as required. The abstract of a recent article summarises the situation as follows:

"Dar es Salaam, Tanzania's water landscape is unjust, inequitable, and uneven. Water rationing and electricity outages affect water availability alongside an overall shortfall in water supply. Using household surveys and interviews, this paper shows that a majority of respondents lack a consistently reliable source of water. To cope with poor access, households alter their daily routines, consume less water, and identify and use

[7] The individual sources that were considerably lower in the survey were tanker trucks (3.9 as compared to 8.4 per cent), unprotected wells (0.6 as compared to 4.2 per cent), but also piped water in the home (14.5 per cent as compared to 20.1 per cent) and tube wells (6.8 as compared to 18.9 per cent). On the other hand, those that were higher in the survey included rainwater harvesting (8.7 per cent in the survey for the rainy season, and not really captured in the census), bottled water (3.7 as compared to 1.2 per cent) and most notably 'other' (13.5 as compared to 0.7 per cent). Some of these differences may relate to sample size problems, but there were probably some definitional differences, including perhaps how drinking water was defined (the survey looks to have taken it more literally as the main source for drinking, rather than the main source of water that could be used for drinking).

back-up sources of water. It is crucial to understand the problems of water availability in the city in order to make more informed policy decisions and more justly provide water access." (Smiley, 2016)

Despite these qualifications, the difference between improved and not improved water sources does capture something of the inequalities in water provision, particularly in combined with other indicators. On average those with the sources designated as improved are almost certainly better served, and more generally better off. Thus, a recently published assessment of multidimensional child poverty in Tanzania found that water poverty, as evidenced by requiring more than 30 minutes to collect water and using unimproved and untreated water sources, overlapped closely with other dimensions of poverty, such as education and housing (National Bureau of Statistics of Tanzania, 2016).

More important, the information on sources can contribute greatly to informing improvement efforts when available at very local levels. In order to implement improvements, it is critical to know what technologies people are currently using. If the information can be mapped, and especially if it can be overlaid with other maps and confirmed and discussed locally, the indicators become far more revealing and locally relevant.

But these qualifications do mean sources should not be taken as adequate evidence of the quality of water provision. Added provisos, such as their being less than 400 metres away and taking less than 30 minutes for a collection trip, do not overcome these deficiencies. Unreliability of supply and contamination of the water can and do afflict virtually all sources including piped; addressing these deficiencies equitably are central to achieving universal access. There is a danger that the international acceptance of the now conventional definitions of improved and unimproved are actively discouraging the Tanzanian authorities from gathering better evidence (Nganyanyuka et al., 2014; Smiley, 2016). More importantly, there is a danger that such definitions are influencing local priorities for action and pushing them towards shifts in the types of facility rather than in their quality, reliability and affordability.

There are ongoing discussions about how better to incorporate quality and reliability into the international monitoring system, but there is no reason to assume that the best way to derive internationally comparable indicators of quality and reliability are the best for driving improvements in Dar es Salaam. Within Dar es Salaam, it would make much more sense to try to take advantage of the continuously improving mapping systems, and to develop a system that builds on local engagements and local priorities and specificities (e.g. saline intrusion). For international comparability, it does make sense to rely on carefully designed sampling, and types of quality and reliability problems whose measurements can be standardised. Reconciling the two would require accepting both common and locally adapted components, each designed to complement the other, recognising of course that the common component would need to complement a wide range of different local components and their diverse contexts. Over and above the challenges of reconciliation, given the issues with water quality and reliability in Dar es Salaam, more accurate measurement of water quality and reliability is likely to greatly reduce estimates of water coverage.

Sanitation

As with water, the international indicators of improved sanitation are based on physical characterisations of the facilities, which do not capture some of the most important deficiencies in quality, especially in urban areas where crowding and density tend to amplify the effects of facilities such as pit latrines, and poorly maintained pit latrines in particular. On the other hand, the official definition of improved sanitation excludes shared facilities, which are very common in urban areas, and whose risks are unclear (Exley et al., 2015). As a result, the sanitation coverage rates with "improved" sanitation are not so obviously over-estimates as is the case with water. On the other hand, they misrepresent the sanitation problem, suggesting without evidence that a large part of the problem is latrine sharing – the more obvious urban sharing problem being the shared of risks of poor faecal sludge disposal.

The sanitation coverage estimates for urban and rural (mainland) Tanzania based on the 2010 DHS survey are shown in Table 5. Compared to water, the coverage is low in both rural (20 per cent) and urban (21 per cent) areas, and the differences in sharing are striking. 57 per cent of urban households shared facilities, mostly with 2 or more households. 20 per cent of rural households shared, mostly with just one other household.

The importance of shared sanitation is also evident in Table 6, which shows both improved sanitation and unimproved sanitation because of sharing (and only because of sharing), each growing steadily from 6 per cent in 1990 to 31 per cent in 2015. In effect, were it not for sharing, urban sanitation coverage would have been twice as high, and would have grown from 12 to 62 per cent. This 62 per cent is not so far from the

77 per cent for water, though in the case of sanitation coverage has been rising, whereas for water it has been falling. As with water, the fact that the shift is the same (in this case 5 per cent every five years) is an artefact of assumptions in the estimation procedure rather than empirical evidence that the shifts have actually been steady.

While the justification for treating shared facilities in Tanzania as unimproved may be weak, at least from the perspective of health risks during use (Exley et al., 2015), increased sharing almost certainly does reflect problems in securing adequate sanitation. Many of the drivers of a growing reliance on shared sanitation, including growing density in informal settlements and a related scarcity of land available for building latrines, are likely to create sanitation problems. Moreover, even if shared toilets are kept clean, queues will be longer, the potential for night-time violence against women is likely to be higher, the pits are likely to fill up faster, and emptying is likely to be more difficult (particularly higher density in informal settlements makes access harder). Treating shared facilities as unimproved may be inaccurate at the individual level, but adjusting coverage rates down in the face of evidence of increased sharing is not unreasonable. The real problem would be if reduced sharing were treated, explicitly or implicitly, as an objective.

To take a stylised example, suppose an informal settlement of 100 households, each with its own latrine, were to double in size with two households now sharing each latrine. It could be misleading to suggest that latrine coverage went from 100 per cent to 0 per cent. It could be equally misleading to suggest that coverage has not changed at all. But by far the biggest mistake would be to try to improve coverage by stopping the sharing, and claiming an increase in coverage from 0 to 50 per cent if successful. This exemplifies the problems with using such rough indicators as though they were measures of coverage.

Table 5. Selected Sanitation Statistics for Urban and Rural Households in Mainland Tanzania 2010 from DHS Survey

	SANITATION		
	URBAN	RURAL	BOTH
	(%)	(%)	(%)
Improved sanitation facilities	**21**	**9**	**13**
Share with 1 other hsehld	13	13	13
Share with 2–4 other hsehlds	28	6	12
Share with 5+ other hsehlds	16	1	5

Source: NBS Tanzania, & ICF Macro. (2011).

Table 6. JMP Estimates of Urban Sanitation Coverage in Urban Tanzania 1990–2015

URBAN SANITATION ESTIMATED COVERAGE 2015 UPDATE				
YEAR	IMPROVED	SHARED	OTHER UNIMPROVED	OPEN DEFECATION
1990	6%	6%	86%	2%
1995	11%	11%	76%	2%
2000	16%	16%	66%	2%
2005	21%	21%	56%	2%
2010	26%	26%	46%	2%
2015	31%	31%	36%	2%

Source: JMP (2016) estimates from

Table 7, based on census data, provides a far more positive picture of sanitation coverage in Dar es Salaam, in part by not excluding shared facilities. Thus, looking at facilities alone, 89 per cent of households have improved sanitation, as compared to 78 per cent with improved water supplies. The low level of open defecation is indeed impressive, even accepting that the open defecation of young children is probably not counted, and some homeless and very poorly housed people were probably not even captured in the census. However, if one judges that pits are not adequate to urban sanitation, then coverage goes way down to 21 per cent. Only a very small share (6 per cent) have sewer connections, and most are using facilities whose quality varies enormously depending on where they are located, how they are maintained, and how they are emptied.

Reports suggest that the quality of the pit latrines is generally poor, with one survey of 662 households in 35 unplanned low-income sub-wards indicating that while 56% used facilities considered improved according to the MDG criteria, only 8% had a functional facility that "could be considered as hygienically safe and sustainable sanitation" (Jenkins et al., 2014: 131). Even in these low income areas, these functional facilities were 2.6 times more frequent among the wealthiest quintile of households surveyed than among the two poorest. The authors point out that deficiencies in the MDG criteria have implications for how acceptable sanitation should be identified for SDG monitoring. Unfortunately for the experts developing the SGD monitoring, the sort of city-specific survey designed around the sanitation deficiencies in Dar es Salaam will not be suitable in other parts of the world, and vice versa, creating a major challenge for international comparability if the intention is to create one approach to fit all circumstances.

Emptying latrines is a particularly important and growing problem in Dar es Salaam. Emptying is expensive; mechanised emptying is difficult in densely settled unplanned areas and, particularly in the central parts of the city, space is at a premium, making it costly and difficult to abandon a latrine and find a new site. Based on the same survey of 662 households mentioned previously, it was found that households "delay emptying as long as possible, use full pits beyond what is safe, face high costs even for unhygienic emptying, and resort to unsafe practices like 'flooding out'"[8] (Jenkins et al., 2015). Similar findings came from a situation analysis of sanitation in Dar es Salaam's informal settlements undertaken by the Centre for Community Initiatives (Mkanga & Ndezi, 2014).

Table 7. Main sanitation facilities of Households in Dar es Salaam from 2012 census

FACILITIES	PER CENT
Flush/Pour water to Piped Sewer System	5.7
Flush/ Pour water to Septic Tank	15.2
Flush/ Pour water to Covered Pit	14.0
Ventilated Improved Pit Latrine	2.1
Pit Latrine with Washable Slab with Lid	22.9
Pit Latrine with Washable Slab without Lid	29.3
Flush/Pour water to Somewhere Else	3.1
Pit Latrine without Washable/ Soil Slab	4.5
Pit Latrine without Slab/Open Pit	3.0
No Facility/bush/ field/ beach	0.2
Total	100.0

United Republic of Tanzania (2015b).

[8] During the wet seasons full pit latrines are inclined to overflow.

There is also evidence of faecal contamination and high nitrate levels in the groundwater of Dar es Salaam, including in the boreholes (Elisante & Muzuka, 2015; Mato, 2002; Walraevens et al., 2015). This is likely to be the result of seepage from pit latrines, even in the absence of flooding out, and is a particularly serious problem given the widespread dependence on groundwater for drinking.

Just as the classification of improved and unimproved water sources is missing some of the most important water quality and reliability deficiencies in Dar es Salaam, so the classification of improved and unimproved sanitation facilities misses some of the most important sanitation risks, including unsafe latrine emptying and seepage from latrines into the groundwater. These risks relate to the ultimate disposal of faecal sludge, and even the sewer system creates significant risks, particularly when the pipes are cracked and/or the sewage is ultimately released untreated or partially treated into local water bodies. If faecal sludge management were taken into consideration as an indicator that contributed to coverage estimates, it is likely that the proportion with access to improved sanitation would be greatly reduced.

These sanitation risks reflect the public nature of the sanitation challenge: while the latrines may be private places, they create public problems, and demand some sort of public solutions. Despite this public character, the burdens fall very unevenly. In the poorer neighbourhoods, the sanitation burdens fall more locally, and residents are more likely to be using shallow wells or polluted boreholes. In the wealthier neighbourhoods, with sewer connections or efficiently emptied pits or septic tanks, the burdens are more likely to be incurred downstream of where the sewage is released, unless it is part of the minority that is treated (Tremolet & Binder, 2013: 10).

Variation in water and sanitation across the city

Both water and sanitation conditions and opportunities vary across the city. The most striking and often cited relate to differences between the very wealthy and the low income informal settlements that make up the majority of the city. One way or the other, the wealthy usually manage to live where they can secure a safe water supply, and sanitation facilities are integrated into the homes according to accepted standards. The low income residents, on the other hand, rely on a wide variety of deficient sources, many within the same neighbourhood. Thus when a recent study compared the household water situation in two wealthy and two poor neighbourhoods, the lists of options used by poorer neighbourhoods were far longer than those used by the wealthy (Nganyanyuka et al., 2014) – despite the misleading stereotype that a big advantage of wealth is that it provides more choice.

Thus, it is especially among poorer households and neighbourhoods that there is geographical variation with the qualities of water supplies and sanitation. The quality provided by simple water and sanitation technologies is more dependent on local conditions. Thus pit latrines in particular are easily affected by high water tables and flooding, and are more prone to collapse in certain types of soils. Dug wells are especially likely to vary in quality and reliability by season, rock/ground type and place, including placement relative to pit latrine and other pollution sources. In Dar es Salaam there is considerable variation in groundwater salinity, even for the boreholes, with some areas of very high salinity near the coast, but moderate salinity from varied sources in more varied locations (Walraevens et al., 2015).

When the centralised systems go wrong, they too create geographically patterned risks. As already indicated, there are central locations where the piped water is meant to be provided continuously, but many dense central areas where it is rationed to a few days a week, and peripheral areas where the water only flows one day a week and everyone gathers to make sure they are there to collect the water. When water is only available at certain times this typically means low pressures in water pipes, making them susceptible to sewage intrusion through any cracks in the pipes. Cracks and holes in the pipes are more common when pipes are being illegally tapped. Cracked sewer pipes are more likely to contaminate water supplies when these rely on shallow groundwater or water pipes that are themselves cracked and intermittently low in pressure.

For lower income settlements, there is a transition in the water and sanitation challenges as one moves out from the centre to the periphery of a city like Dar es Salaam. For water, higher density near the centre reduces per capita costs of and accessibility to the piped systems and increases the likelihood of groundwater contamination, though some polluters may be displaced to the periphery. For sanitation, higher density and land values create problems locating latrines, which are also likely to have larger adverse effects if they

pollute the ambient environment or groundwater. In the peripheral areas sanitation is rarely perceived to be such a problem, though the facilities may be poor, creating risks.

2.3 An example of community-based water and sanitation ladders in Dar es Salaam

The following section considers how and why data relating to water and sanitation provision is gathered in low-income communities and outlines a community-driven process to develop water and sanitation ladders around local perceptions of progress and acceptability. The community "ladders" can support grassroots water and sanitation initiatives, but are also useful to challenge the global indicators that monitor national and global water and sanitation progress and how global indicators influence sector programming.

Low-income urban communities collect data to understand and respond to local development challenges and deficiencies; the responses tend to be orientated around influencing local sub-ward, ward and city processes (see Patel & Baptist, 2012). The Centre for Community Initiatives (CCI) and the Tanzanian Urban Poor Federation (TUPF)[9] have been mapping and profiling low income and informal urban settlements, and undertaking household surveys to document local needs and plan responses to upgrade informal settlements, through practical interventions and partnerships with state and sector stakeholders. The local responses that are developed from this data contribute to improving access to water and sanitation (see Banana et al., 2015). The data sets are localised and nuanced, revealing some of the detail that is not captured in national surveys of the census. However, this local data is incompatible with the official monitoring systems, which makes it difficult for local actors to influence global processes and programming and to secure associated funding to support local water and sanitation initiatives.

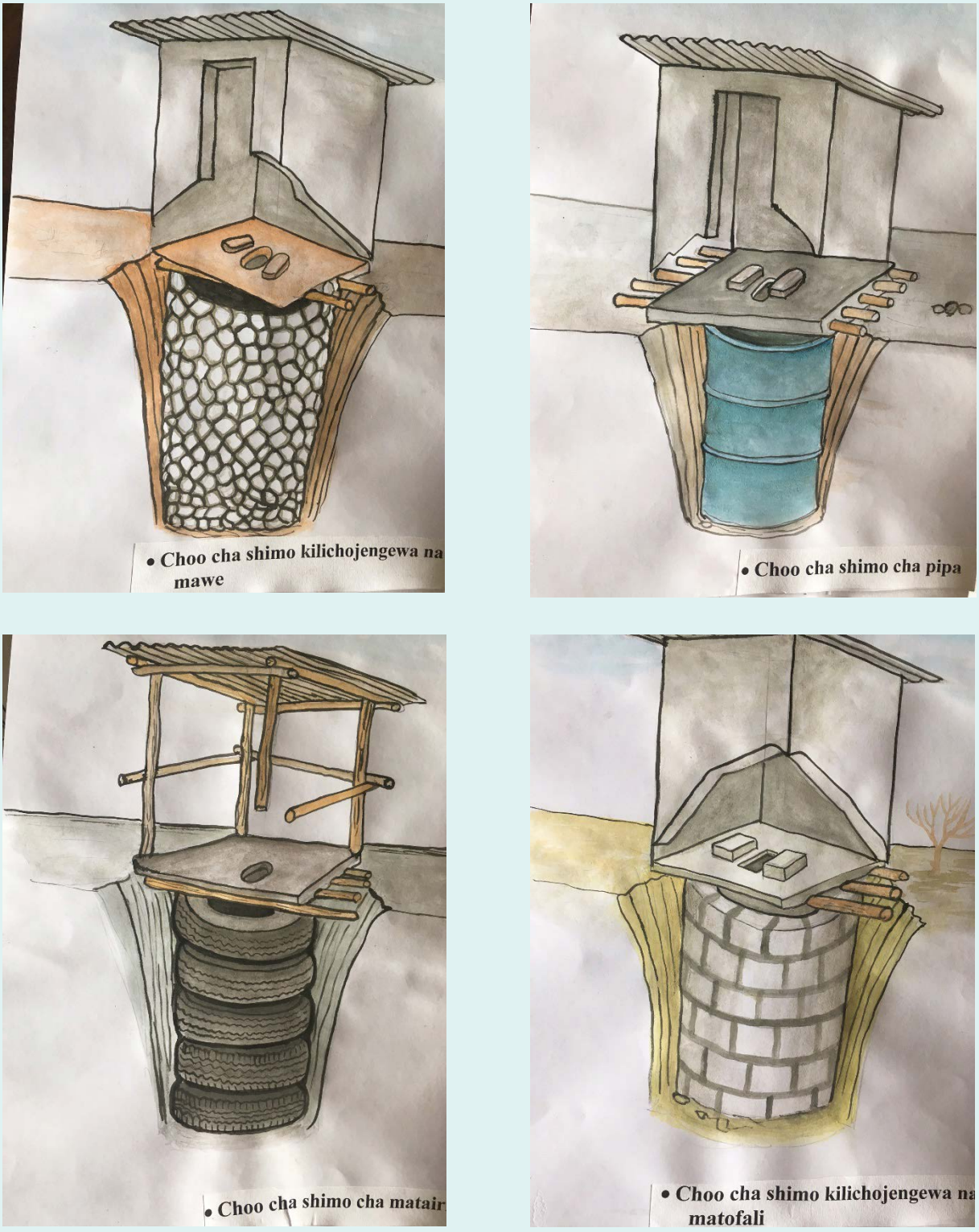
Why communities collect data

Community-led data collection in informal settlements is widespread and undertaken in cities across the global South (see Buekes, 2015). Collecting data that can be used to draw accurate maps is often the first step in this process. If informal communities are absent, formal maps and city plans that establish boundaries which are recognised by others is a powerful step towards legitimisation. Subsequent mapping and data collection can be more strategic, as communities decide on what they will map and how, including the level of detail, method, and how it is presented (for example the scale and diversity in formal and informal water and sanitation provision within informal settlements). This could include categorising the sources of water used, the formal and informal providers that exist, the technologies for delivery of water and sanitation, and the informal adaptations made to lower cost and the implications that this has for the user and local environment. If communities are networked across the city, then mapping service provision can demonstrate variation in access to water and sanitation across cities, and the realities of water and sanitation provision in unplanned and informal settlements. Data that demonstrates the diversity and inequality that characterises access to water in sanitation within and between communities in cities in the global south is useful to challenge the broad rural urban classifications used to capture progress globally and nationally.

Global progress in terms of access to water and sanitation has been defined by the JMP ladders of water and sanitation, and tends to focus on the water and sanitation technologies that can provide solutions. The acceptable technologies adhere to certain standards and have certain characteristics, which are not explicitly stated in the ladder. Local water and sanitation maps reveal that the provision that emerges in informal settlements might not neatly fall into the technological categories identified. In contexts characterised by high degrees of informality and diversity of water and sanitation provision, community understandings of progress tend to focus on the diverse features of water and sanitation services and the impact that they have on the user and the environment, which in turn shape solutions as outlined in the illustrations below.

[9] TUPF is affiliated with Shack/Slum Dwellers International with networks federations of the urban poor in 32 countries across the global South. CCI is a support NGO that work with TUPF

Figure 2. The illustrations above were used in a community workshop on water and sanitation and highlight how pit latrines can be lined with a range of materials



Illustrations by Abdul Aziz Mkilalu

Building community ladders

Global water and sanitation monitoring has limited scope to reflect on the acceptability of the diverse and varied water and sanitation services across cities in the global south from the perspective of users. Community-driven processes to classify sanitation types and to agree on what constitutes progress could provide a useful compass for communities to plan and chart upgrading, while also providing a useful contrast to the global ladders and associated understandings of progress.

As part of a research project convened by IIED, The Centre for Community Initiatives and the Tanzanian Urban Poor Federation have been engaged in a process of extending the mapping of water and sanitation in three informal communities in Dar es Salaam, namely Mtoni, Kombo and Tungi,[10] and developing community water and sanitation ladders to understand acceptability. The community mappers work in collaboration with sub ward leaders and are trained and monitored by skilled personnel to guide them in order to ensure accuracy of the mapping data collected.

The maps that were produced were used to begin discussions amongst community members about what constitutes unacceptable, acceptable and ideal water and sanitation provision at the community level. Focus group discussions were held in each of the three communities, where community members discussed which local water and sanitation services were unacceptable, acceptable and ideal, and why. Discussions eventually moved away from technologies because there was so much variation in the types of water and sanitation within communities, for examples pit latrines can take many different forms, and standpipes can provide water from various sources and be managed by a range of different actors. Consequently, discussions came to focus on a series of features instead of specific water and sanitation technologies. In doing so, communities have developed their own ladders of water and sanitation based on unacceptable, acceptable and ideal features, which reflect local water and sanitation needs and provision. The focus group discussions built on mapping, data collection and practical and strategic interventions linked to water and sanitation by the Tanzanian Urban Poor Federation and CCI in three communities, and did not intend to be representative of the low-income urban experience. Instead, the ladders aim to capture grassroots perspectives on the acceptability of water and sanitation provision in informal settlements, to support local processes aimed at improving access to water and sanitation. By examining three distinct focus groups and three distinct sets of ladders, it is clear that there is cross-community agreement on certain features, while the acceptability of other features are shaped by local context. In an attempt to try to move beyond some of the very local specificities that have shaped the water and sanitation ladders that were developed in each community, representatives from each of the communities came together to develop water and sanitation ladders that they felt could be useful for low-income and informal unserved communities across the city of Dar es Salaam. Certain categories were combined and edited to simplify the ladders. The outputs have been useful to consider the scope that JMP ladders really have to captures and support progress in low-income and informal settlements.

[10] **Mtoni**: Multiple private boreholes, some with distribution networks that exist alongside the utility network. Utility network is not reliable. Boreholes are managed by private vendors and there is one community-managed system. A natural well and shallow wells also supplement water use. Pit latrines are widely used.
Kombo: During the 1980s communities used water from a local river, shallow wells and two natural springs. Now boreholes are widespread. There were several cholera outbreaks in the area in the 2000s. In 2016 the DAWASA network started providing connections in the area for those who could afford the connection fee. At the time of writing a connection from a private borehole cost half the cost of connecting to the DAWASA network. Some experimentation with simplified sewers connected to nearby stabilisation pond. Pit latrines are widely used.
Tungi: Boreholes and vendors are widespread. Hand-dug wells providing free saline water for non-consumption needs are common and often shared between compounds. Pit latrines are widely used.

Figure 3. Community Sanitation Ladder

SANITATION	☹ UNACCEPTABLE	😐 ACCEPTABLE	☺ IDEAL
EXAMPLES	Unlined and poorly lined pit-latrines (using barrels, tyres etc)	Soak-away pit/pit latrine with Asian squatting pan, which does not transmit diseases	Sewer connections (including simplified)/septic tank/ vacuum tank emptying
ENVIRONMENT	Wastewater flows to immediate environment	No impact on immediate environment	Toilet is well constructed; wastewater does not flow to neighbours, or contaminate environment/ groundwater sources
CLEANLINESS	Full pit, causes back flow; dirty toilet, poor ventilation, damp, fungus and mould	Clean inside and easy to keep clean	Cleanable floor and tiles, with tools and products available for cleaning; hand washing facility
STRUCTURE	Uses cloth, sacks, tree branches etc	Needs a roof, walls and door; lined with bricks or blocks, slab with durable wood	Brick construction; well built, with opening for ventilation; door for privacy
WASTE REMOVAL	Manual emptying; opening and flooding of pit during the rainy season; abandoning pits	Safe emptying without polluting the environment; no manual emptying	Waste removal safe, affordable and appropriate to local context — eg sewers, simplified sewerage or vacuum tankers
SHARING	More than five families sharing	2–4 HHs sharing; 8–20 people	No more than one family or 5–6 people sharing
COST	Usually more than TSh2 million (excessive cost); lower than TSh400,000 indicates poor quality toilet	For HHs to build new toilet: TSh1–1.5 million (high cost due to need to dig pit and buy tank)	For HHs to build new toilet: TSh600,000–800,000
WATER FOR SANITATION	Men should use between 20 and 5l; women between 30 and 10l	Water needed, same as for ideal (20–30l)	Men approximately 20l; women 20–30l
PRIVACY	No door, no privacy	Lockable door	Men: toilet can be inside or outside of house but tank/pit should be outside; women: inside toilet preferred unless plot is fenced

HH: household

Figure 4. Community water Ladder

		☹ UNACCEPTABLE	😐 ACCEPTABLE	☺ IDEAL
WATER	PROXIMITY TO HOUSE/USER	More than 30 minutes	No more than 5 minutes from the house	Ideally, taps in kitchen and bathroom (particularly important for women); at least tap at yard level
	TIME TO COLLECT	Daily water collection takes 1.5–2 hours	Not more than 15 minutes to collect daily water	Negligible as in house/yard
	TREATED	Not treated	Treated to water utility standards	Treated to the level of the water utility (for cooking and drinking, might boil)
	TESTED	Not tested	Tested to water utility standards	Tested to water utility standards
	COST	1 bucket for TSh300; more than TSh30,000 monthly per house; more than TSh10,000 monthly per HH	HH connection no more than TSh350,000; affordable monthly cost per house TSh15,000–30,000 (TSh7,000–10,000 per HH)	TSh200,000–250,000 to get HH connection; TSh15,000–20,000 monthly per house with multiple HHs sharing (TSh3,000–4,000 monthly per HH); some prefer metered, others flat rate
	RELIABILITY	Frequent rationing (up to twice a week)	Water available 6–12 hours per day; morning and evening availability important	Safe water available 24/7
	SOURCE	Shallow untreated well; piped network through drainage channels; borehole near toilets	Dar es Salaam Water and Sewerage Corporation, wells, boreholes (if treated and tested); accessing multiple sources for different uses acceptable; people prepared to walk further/take more time to collect drinking water	Utility water ideal, but also deep boreholes
	STORAGE	None or near toilets	Yes	Storage of approximately 100l for emergency situations, eg power cut
	QUANTITY	Less than 15l per person per day; water for sanitation is additional	60l for small family; 110l for large family (15–20l per person per day); water for sanitation is additional	80–100l per HH per day (20–30l of water per person per day); water for sanitation is additional

HH: household

During discussions about ideal and acceptable water sources, all three communities agreed that all water sources are acceptable if treated and tested to the same levels as that provided by the water utility in Dar es Salaam. Groundwater is a common source of water in low income settlements in Dar es Salaam, but its quality and salinity vary enormously. Communities perceive local groundwater sources provided through local vendors to be acceptable if tested and treated. This has implications for plans to extend water services in informal settlements, specifically the water sources that could be used if sustainably managed, treated and tested, and the role that informal vendors might be able to play in extending provision. In practice, many of the participants relied on multiple water sources; in Mtoni in particular, shallow wells are widespread and provides a complementary water source to the other sources in the community, the shallow well water is used for washing. These sources, unless treated were not deemed to be acceptable.

Participants reported that they were using less than 15 litres per person per day in total for both water and sanitation needs. During the cross-community discussions, participants agreed that anything less than 15 litres of water per day was unacceptable, 15–20 litres was acceptable, and 20–30 litres was ideal. Supplementary to this was water required for sanitation needs. It was unacceptable for women to have less than 10 litres per day for sanitation, and men less than 5 litres per day. Acceptable and ideal sanitation provision would require at least 20 litres for men and 30 litres for women. The issue is made more complex by the fact that most households use multiple water sources. Community leaders were unable to develop water ladders that took into consideration multiple water sources in a useful way, particularly in terms of their acceptability for use for sanitation, but this is an issue that CCI and the TUPF continue to contend with.

The extent to which households are willing to share sanitation facilities seemed to reflect common living arrangements in low-income settlements in Dar es Salaam. These might not extend to other low-income urban settings, but reveal that communities see shared sanitation facilities in a compound among specific neighbours or tenants as acceptable. Ideally, communities agreed that each family should share one toilet. However, given that informal settlements in Dar es Salaam are characterised by compound living, where several households might share one toilet, communities agreed that it would be acceptable for between two and four households to share a toilet. The variation reflects the fact there is a spectrum of acceptability from community to community, and the fact that household sizes vary.

Shared public toilet blocks that are open to all were always deemed to be unacceptable. The question of sharing toilets and toilet blocks has always been contested. At a global level, the JMP states that toilets that are shared by more than two households are not acceptable. However, the physical and cultural realities of living in an informal settlement means that the acceptability of sharing sanitation facilities varies within and between cities. In densely populated urban settlements, public toilet blocks can play a significant role in improving access to sanitation at scale, as observed in Indian cities as part of the National Sanitation Policy (Patel & SPARC team, 2015). In Dar es Salaam, households suggest that it is acceptable for more than two families to share a toilet, reflecting the proliferation of compound-living in a context characterised by high degrees of household rental.

Table 8. Community water needs

	WATER	SANITATION	TOTAL
Ideal	20–30 litres pp per day	20 litres pp per day (men) 30 litres pp per day (women)	40–50 litres pp per day (men) 50–60 litres pp per day (women)
Acceptable	15–20 litres pp per day	20 litres pp per day (men) 30 litres pp per day (women)	40–45 litres pp per day (men) 45–50 litres pp per day (women)
Unacceptable	<15 litres pp per day	<5 litres pp per day (men) <10 litres pp per day (women)	<20 litres pp per day (men) <25 litres pp per day (women)

Building in some flexibility to local water and sanitation ladders allows local actors to respond with technologies and ways of using water and sanitation that reflect local realties and respond to the complexity that characterises informal settlements.

Progress along JMP sanitation ladders implicitly specifies sanitation technologies that remove wastewater and do not have an impact on the local environment. The sanitation focus groups immediately focused on the environmental and health impacts of poor sanitation as a key characteristic required for acceptability. The discussion focused on the roles and responsibilities of the household and other sector actors in storing and removing wastewater. It was agreed that the household or landlord should construct and maintain toilets that stored wastewater locally, but that infrastructural support was needed to take wastewater off site. This neat division of labour is not easily achieved in a context where less than 10% of households in the city has access to a sewer, and pit latrines in low-income households are often lined with a range of informal materials that might not protect the local environment. Emptying might be undertaken manually, or pits might be flooded out during the rainy season, which has serious implications for the local environment and the health of residents during this period. Households that are renting might not know what sort of pit latrine they are using nor its impacts on the local environment and the groundwater supplies that are a significant water source for many households. This provides an opportunity to consider how acceptable wastewater removal can happen in a setting where roles and responsibilities are unclear and often unfulfilled.

The ladders are not only a means of charting progress but can also provoke discussions about how incremental progress could be achieved and the associated roles and responsibilities. Households might need to consider exactly what sort of pit latrines they are using and/or could build and how wastewater is stored; they can also identify improvements that can be made immediately in order to incrementally improve water and sanitation facilities. This could include issues of privacy or cleanliness. Communities can also identify which improvements require collective action at the local level and/or strategic engagement with external sector actors for support, for example, around wastewater removal in informal settlements. This supports the idea of incremental improvements in water and sanitation provision that can be undertaken by the community and/or in partnership with other sector stakeholders. In that sense the community ladders could usefully contribute to the debates around the progressive realisation of water and sanitation improvements, which have been central to discussions relating to global water and sanitation goals.

2.4 Improving water and sanitation in Dar es Salaam's expanding informal settlements

It is extremely difficult institutionally to manage low-cost water and sanitation systems well in low-income urban informal settlements generally, and this is evident in Dar es Salaam. For the very poor, even the low-cost systems incur costs that can be difficult to bear. Constructing, monitoring and maintaining these systems to keep them functional and safe requires careful management, high levels of cooperation and significant allocations of time. Moreover, for a variety of reasons, residents rarely have an incentive to devote the time and resources that these systems require. This should not be taken to imply that they don't care about the quality of their water, sanitation and hygiene. Indeed, an anthropological study of women living in one of Dar es Salaam's informal settlements found that women were very concerned and heavily influenced by the prevailing health and hygiene messages, if not necessarily in a constructive way (Obrist, 2004, 2006). At least in part, this is because, while hygiene and sanitation are treated as private affairs which should be each household's own responsibility, in practice bad sanitation is a very public problem.

The need for low-cost improvements of poorly constructed, maintained or used on site sanitation facilities with serious public impacts, cries out for neighbourhood-scale collective action and support from an urban utility acting in the broader public interest (Mara & Alabaster, 2008; McGranahan, 2015). Open defecation and poor latrine emptying contaminate the neighbourhood, a poorly built pit latrine or septic tank contaminates the groundwater, and a flush toilet releasing untreated sewage contaminates the water for downstream users. In principle, a well organised community with appropriate norms can address such problems, but, without collaboration from a public utility or well-developed and regulated latrine emptying, communities are unlikely to handle the ultimate disposal of faecal sludge safely. This creates problems for the city and beyond. Not all utilities dispose of faecal sludge safely, and DAWASCO currently releases a significant share of the sewage it handles untreated (Tremolet & Binder 2013). It is likely to require difficult political decisions as well as non-political regulation to bring the sanitation system, and DAWASCO's contribution to it, more into line with the public interest.

Water is closer to the typical sort of commodity bought and sold in conventional urban markets, but it, too, poses institutional problems for private as well as public suppliers. There are many potential sources of

private and public failures. Delivering water door to door is extremely costly, collecting water in containers very laborious, and it is difficult to ascertain the quality of water. Digging a well is reasonably cheap, but in most of Dar es Salaam the water is likely to be highly contaminated, particularly if it is near a badly built pit latrine. Tube wells are often able to tap cleaner water, but require investments and may contribute to saline intrusion. Selling water from tube wells and other water sources is prone to monopolisation resulting in excessive prices, though in some cases public pressure can be brought to bear. Household water connections are cheaper to supply than sewer connections, but are nevertheless expensive, particularly at low densities. Until most residents are provided with water, a rare condition in rapidly growing low-income cities, subsidies will tend to be diverted, along with the piped water, to better off residents. There is also water theft, including from the piped water system. Indeed, in Dar es Salaam roughly half of the piped water supplies are unaccounted for, which includes leakage but also an unknown level of illicit water tapping or official connections that, whether or not payments are being made, are not captured in the formal budget.

Informality often contributes to the institutional challenges of improving water and sanitation. Informal settlements can be defined as residential settlements built without formal planning approval or not in compliance with regulations (OECD, 2008; Park & Allaby, 2013). In Dar es Salaam, and elsewhere, this covers a wide range of housing, and does not cover all or only low-income communities. However, informal settlements often become endemic when a large share of a rapidly growing population has lower incomes than the formal planning processes and regulations allow for (McGranahan et al., 2016). Estimates of Dar es Salaam's population living in informal settlements tend to be between 70 and 80 per cent of the city's total population (Kombe et al., 2015; Limbumba & Ngware, 2016). It is possible that some of these estimates are actually based on estimates of "slum" population identified by UN-Habitat as households that lack either improved water, improved sanitation, durable housing, or sufficient living space (UN-Habitat, 2012, page 149).

Informality, in the sense of lacking planning approval and compliance, tends to amplify water and sanitation problems through at least two routes. First, the lack of planning can make authorities less able and willing to provide acceptable water and sanitation. Second, the insecurity of informality can render homeowners, as well as tenants and illegal occupiers, less willing to invest in better facilities. As regards to the authorities, it is difficult to disentangle their reluctance to support these communities due to a general lack of capacities and resources from a reluctance related to informality. Similarly, within communities it is hard to disentangle the effects of poverty from those of informality (many multi-dimensional indicators of poverty include indicators of water and sanitation provision, partly because income measures are insufficient to capture poverty (Alkire et al., 2014; National Bureau of Statistics of Tanzania, 2016), and, as noted above, so do indicators of slums). Moreover, to the extent that informality reflects regulations not designed for the lower-income majority, simply enforcing existing regulations is likely to make things worse for that majority.

In most rapidly growing cities in low income countries, this informality creates complex water and sanitation systems involving mutually reinforcing processes that make it difficult to pursue universal water and sanitation coverage in a concerted and equitable manner. In Dar es Salaam, the negative effects of informality on water and sanitation are tempered by a comparatively high degree of acceptance of informal development at the very local (e.g. sub-ward) level (Kombe & Kreibich, 2001). There are still evictions and problems of inadequate compensations when it comes to public land acquisition (Kombe, 2010), but informal land plotting and sales are often developed through local organisations and sanctioned by ward authorities. Moreover, as already noted, DAWASA and DAWASCO have been encouraged to extend water services to informal settlements and have units for supporting community managed water systems, whether the water originates from their piped system or from boreholes. The result may not be as participatory and transparent as it is on paper (Rugemalila & Gibbs, 2015, pages 8–9), but this is indicative of a relatively positive relationship between authorities and residents. DAWASA and DAWASCO are less involved in sanitation in lower income areas, but implicit official support for sanitation improvement is evident with the manual for urban CLTS recently published by the Ministry of Health (2016).

Nevertheless, even in Dar es Salaam there are a number of ways in which informality is creating barriers to improvement. Neither top-down target-led processes nor community-driven processes are getting the support they deserve, and coordination between the two is weak. Looking forward, the challenges differ between the denser central areas and the more dispersed but rapidly growing areas on the periphery of the city. In more centrally located informal areas, sanitation is particularly problematic, as severe problems arise where land for the provision of new toilets is crowded out and encroachments narrow the roads to pathways, making emptying more difficult. Most of the poorer households in the central areas are tenants, and relations between structure owners and tenants are particularly problematic for sanitation (Isunju et al., 2011; Scott et al., 2013). But, for water as well as sanitation, upgrading dense informal settlements is much more costly and disruptive when the incremental residential construction has been done without taking future infrastructure

needs into account. Settlements can be re-blocked, and engaging with organisations of the urban poor can mitigate the effects of upgrading. Well done upgrading is likely to be far better for the residents than relocation, but if engagement could be pro-active and avoid the creation of these barriers, it would be better still.

In the more peripheral areas where settlement is less dense, low-cost decentralised sanitation options are more suitable, and water is the more pressing problem, at least from the residents' perspective. Development proceeds well beyond the reach of existing piped systems. In Dar es Salaam, upwardly mobile households are often the pioneers, moving out to where they can afford a plot of land to build a home on, and perhaps eventually additional structures for relatives or tenants (Andreasen & Agergaard, 2016; Andreasen et al., 2016). They grapple with a range of service deficiencies, ranging from water and sanitation to electricity and transport, by private or self-provisioning where possible or lobbying and/or paying for formal extensions when that is an option (Andreasen & Møller-Jensen, 2016). In many ways this system is much better suited to these households than developer-led housing, which most could not afford, and for which the increasing land values associated with service provision typically accrues to the developers rather than the residents.

As Dar es Salaam expands inland, boreholes are a major source of household water, particularly away from the major transport arteries where piped water may be available. Many boreholes have been sunk, often serving a cluster of households in the vicinity, perhaps even with piped water. Many also provide water to tanker trucks taking water to more distant houses or settlements. The water costs are high, but compensated by the low land prices and the hope that water and other services including roads will improve, improving living conditions and driving land values up. In many ways, the system is operating well, but the borehole owners and operators are not concerned with the long term impacts that their collective activities may be having on groundwater quality and supplies. There is clearly a potential role for DAWASA and DAWASCO here in assessing the consequences and overseeing or limiting the expanding groundwater use, but while a resource assessment is underway (DAWASA, 2016), it is not clear whether they will have the capacity or mandate to play this role effectively.

As this brief description makes clear, the challenge of universal water and sanitation provision is far more complex than one of simply rolling out improved water and sanitation services more quickly to meet some clearly defined target. Most of the existing systems for household water, and virtually all of those for sanitation, are a far cry from the piped systems that best suit conventional urban utilities with well-defined targets. This is in part because the conventional piped systems, particularly for sanitation, are too expensive and inflexible to meet most of Dar es Salaam's needs, at least given existing economic and political resources. Generally, however, while it is easy to criticise current practices, it is difficult to map out realistic alternatives that avoid potentially harmful compromises.

Since DAWASA and DAWASCO and the institutions responsible for regulating water and sanitation provision do not have the resources needed to meet their responsibilities in a formally acceptable manner, corners are inevitably cut. This is very difficult to do fairly, efficiently and informally. The natural tendency is to try to meet short term responsibilities for which the bureaucratic or political pressures are greatest, and to ignore other responsibilities even if these are critical to the future of the water and sanitation system. Much also depends on what funding is made available for, which is not entirely under control of the water and sanitation sector organisations, or even of the government of Tanzania.

It could make a big difference to shift the more formal planning towards a system based on realistic projections of both population growth and the resources available to extend water and sanitation services. When implementation takes place under fewer resources or greater demands than were planned, the tendency is for services to flow to the better off and for unplanned interruptions to incur heavy costs. When the water and sanitation planning is decoupled from other forms of city planning, including planning to open up new land for urban settlement, planning for the densification of existing urban settlement.

In the more central parts of the city, distance may be less of a challenge, but getting the water in and the faecal sludge out (or treated onsite) can be more of a challenge. Realistic plans are needed for filling in areas the piped water system has not reached and reducing the rationing where it has. Efforts could also include Community Led Total Sanitation being promoted by the health ministry (Ministry of Health, 2016), and support for the sort of initiatives led by the Tanzanian Urban Poor Federation and the Centre for Community Initiatives described in section 2.3 above. One of the key roles of the public service providers in wealthy and poor neighbourhoods alike is removing and treating faecal sludge, and this requires not just a financially viable model, but good relations with local residents and their organisations, especially in low income areas where people cannot afford expensive facilities.

In the expanding peripheries, it is even more important to link the water and sanitation planning to broader urban planning processes. It is useful to consider the sort of urban expansion promoted through the NYU urban expansion programme (Angel, 2015). This approach involves mapping out the area of the city's

expansion over the coming decades (based on realistic population projections and densities), bringing this area under the city's planning authorities, securing rights of way for an eventual arterial road grid, and securing protection for a hierarchy of public spaces. This planning would be informed by an understanding of water resource and drainage possibilities and, in turn, provides the basis for planning extending water and sanitation services. The water and sanitation could be extended more or less formally, but in either case in a manner consistent with other key elements of the planning system.

To engage effectively, however, it is important not to simply view the informal expansion of the water and sanitation systems as an object for guidance and regulation, but rather to see it as a complex system that is self-organising with both weaknesses and strengths. In this, it is much like a market-based system, which to some degree it is. For many of the people driving the expansion of Dar es Salaam's periphery, water and sanitation are part of their broader strategy of achieving economic and social advancement through securing land on which to build a home and invest in the future. A strength of the system is that it allows ordinary residents an opportunity to secure the benefits of rising land prices that accompany such development – benefits which, under many urban systems, flow to developers. A weakness is that it has become dependent on groundwater resources whose sustainability is doubtful. The key challenge is to engage with the informal expansion in ways that build on such strengths and address such weaknesses. A second challenge is to do this without opening the door to corruption. This should, in principle, be comparatively easy in Dar es Salaam, where the informal expansion is not as illicit and illegal as in many countries.

2.5 Household water and sanitation use and upstream/downstream/underground problems

Even the best household piped water systems are unsustainable if there isn't enough clean water to continue filling the pipes. In Dar es Salaam there are water resource challenges with the surface water as well as the groundwater. Securing sufficient water to provide the minimal acceptable supplies for everyone is likely to be a challenge. That challenge will be amplified if a growing share of affluent households become profligate water consumers, other competing demands for water increase, droughts become more common, groundwater resources continue to be depleted and contaminated, and there continue to be high levels of unaccounted for water and leakage from the piped system. This subsection draws heavily on a recent review of Dar es Salaam's water resource issues (Walnycki et al., 2017), undertaken as part of the same study this paper is contributing to.

DAWASA estimates that DAWASCO provides water to 68 per cent of Dar es Salaam's population, although historically the reliability of the service has been intermittent and the figure of 68 per cent probably refers to the DAWASCO service area rather than the somewhat larger city-region of Dar es Salaam. As illustrated in Table 9, until recent upgrades, the maximum water "production" available to DAWASCO was 300,000 cubic metres a day (which, if distributed equally and without losses to all of the 5 million or so people in the city-region of Dar es Salaam, would provide them each with 60 litres a day). DAWASA estimated daily demand for water at 450,000 cubic metres, and priority was given to expanding the production and supply from water treatment plants on the Ruvu River. Recently, the available water production was upgraded to an estimated 500,000 cubic metres a day. There are plans to continue the expansion with a view to increase production to 756,000 cubic metres a day by the end of 2018. There are also plans to lower unaccounted for water from 50 per cent of production down to 35 per cent. With these supply shifts ongoing, attention is turning to the extension of household connections or at least nearby standpipes to the rest of the population in DAWASA's service area (DAWASA, 2016).

The future sufficiency of piped water sources for Dar es Salaam cannot be assumed, however. Surface water supplies from the Wami/Ruvu River already dominate DAWASA's supplies (see Table 9). The increasing diversion of water from the Ruvu River to Dar es Salaam increases competition over the Ruvu basin's water supplies, as well as having environmental consequences and constraints. In the 1990s, droughts reduced the water below estimated production levels, and it has been estimated that this is still likely to occur up to 10 per cent of the time in the future (Walnycki et al. 2017). Climate change is increasing the uncertainties. The production of water for Dar es Salaam is already diverting water from other potential users in the basin and from environmental water requirements. The planned upgrades are already close to the maximum assessed potential (Walnycki et al. 2017). Moreover, the groundwater resources that those in Dar es Salaam without access to the piped water system still depend on is already under threat.

The shallow coastal aquifer – the Dar es Salaam Quaternary Coastal Aquifer (DQCA) – currently provides water to large parts of the city that are unserved by the utility through thousands of private and

Table 9. DAWASCO water sources before and after recent upgrades

WATER SOURCE	PRODUCTION PRE-UPGRADES (M^3/DAY)	PRODUCTION LATE 2016 (M^3/DAY)
Lower Ruvu River Water Treatment Plant	182,000	270,000
Upper Ruvu River Water Treatment Plant	82,000	196,000
Kizinga River * (Mtoni) Water Treatment Plant	9,000	9,000
DAWASCO Off-grid Boreholes	27,000	27,000
Total	300,000	502,000

Source: DAWASA (2016)
* The Mtoni water treatment plant draws on some off-grid supplies as well as the Kizinga River.

community boreholes. Declining water levels, saline intrusion and pollution from the urban environment – particularly from the widespread use of on-site sanitation – are putting the aquifer under stress. But for many households, as described in previous sections of this paper, a borehole is the main source of water. Figure 5 provides estimates of the DQCA water balances, and indicates that the extractions (estimated at 3.7 m^3/s) are more than the recharge (2.3 m^3/s). This confirms the claim that the shallow coastal aquifer is currently being overexploited, and that efforts need to be made to better understand and manage this critical resource.

The piped water is distributed along the network outlined in Figure 6 and, as indicated, the network would require a major expansion to reach all of the planned areas of Dar es Salaam and another major expansion to reach the unplanned areas that have developed informally. Moreover, as illustrated in Figure 7, the fastest population growth rates are currently on the periphery where the piped network is absent or barely present (see Figure 6), including in areas identified as unplanned or agricultural. It is unclear how future scarcities of ground and surface water will be experienced or distributed across the city, though existing patterns suggest it will not be equitable (see Walnycki et al. 2017).

Figure 5. Water balances of Dar es Salaam's Quaternary Coastal Aquifer (figures in m^3/second)

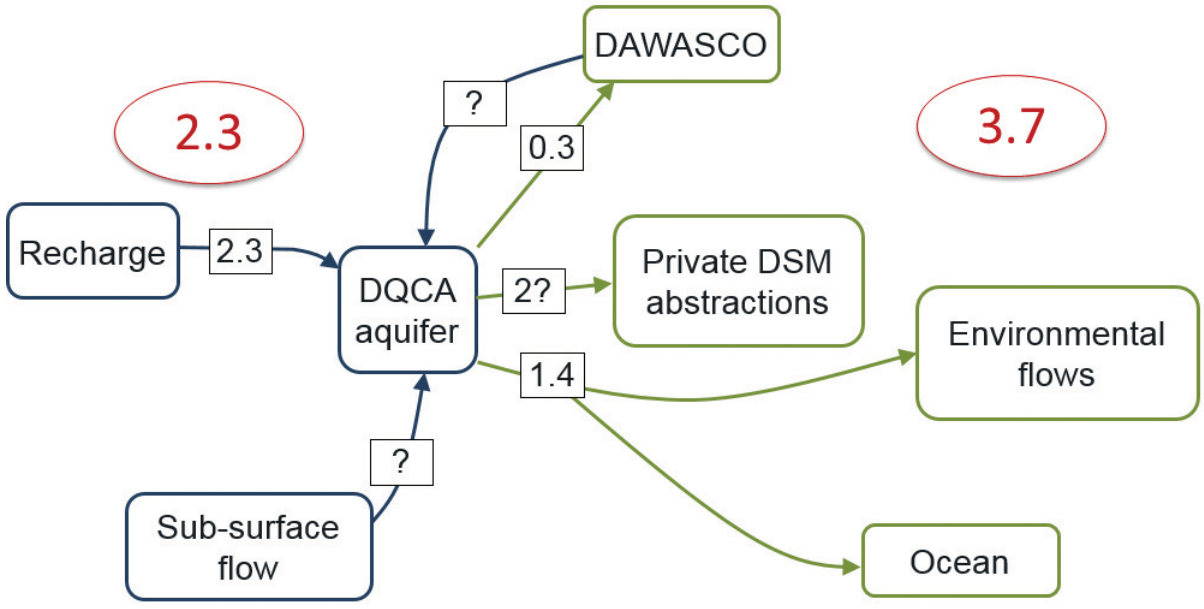
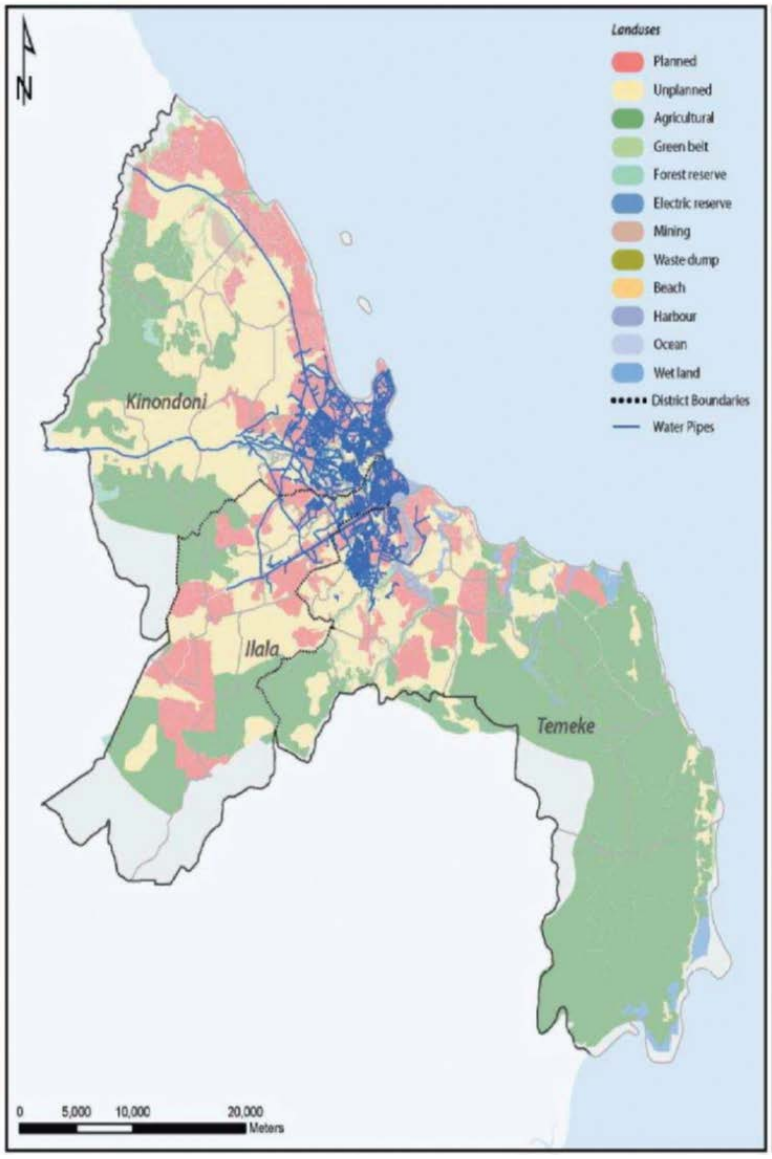


Diagram: Joe Gomme for Cities and Basins project

Figure 6. Map of piped water network and land use in Dar es Salaam

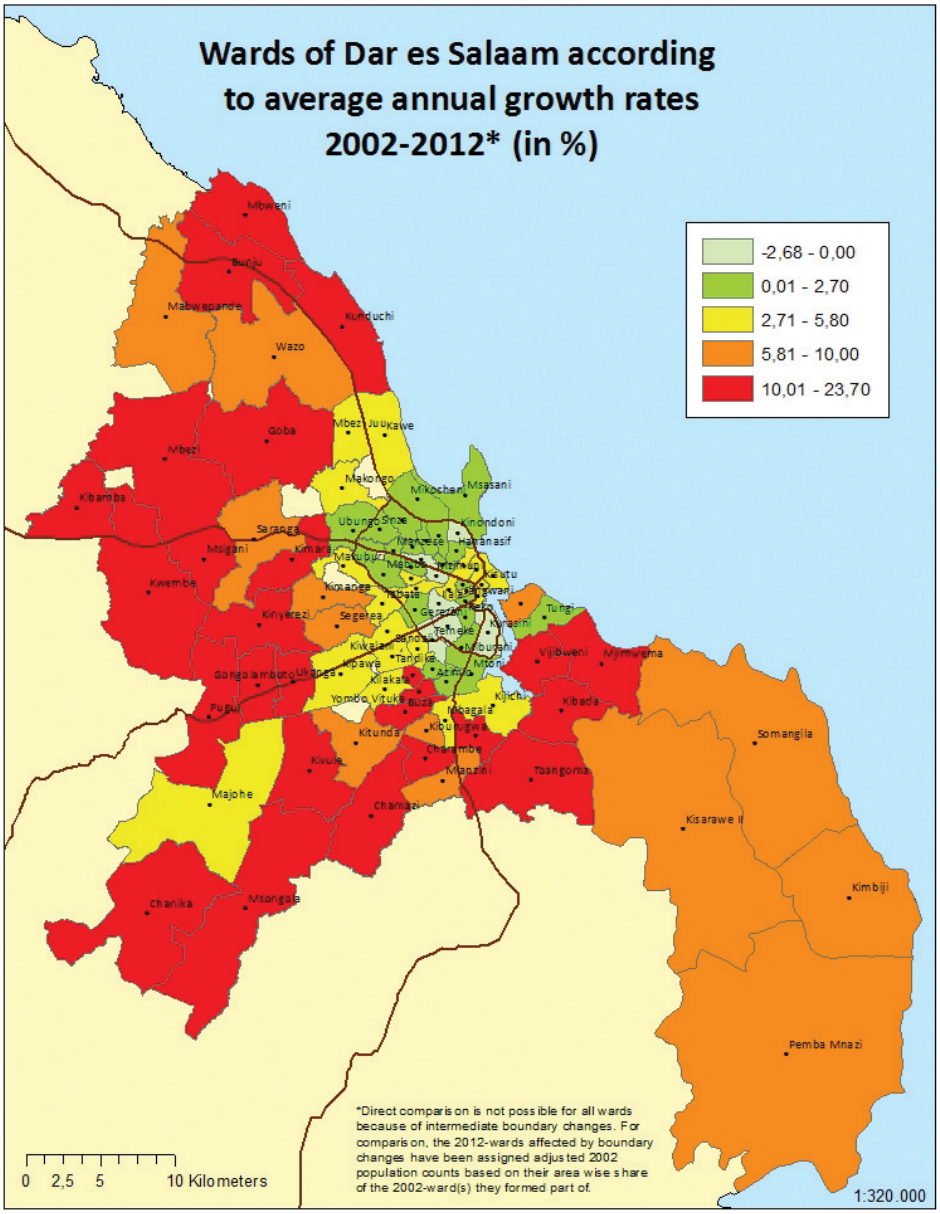


Source: URT (2015): Dar es Salam City Master Plan 2012-2032

The Cities and Basins project adopted the same water demand model used by DAWASA, undertook a water modelling exercise that provides estimates of water supplies and demands up to 2032. By this time, according to SDG targets, Dar es Salaam will have universal coverage with both water and sanitation. The results suggest that water resource supply challenges are likely to preclude universal coverage unless the basin's water resources are carefully managed. Supply deficiencies will not be overcome by simply increasing water production from existing groundwater and surface water resources.

The best available estimate of available resources suggests that the city may be 300,000 m3/d short of the demand calculated in DAWASA plans by 2032 (see Walnycki et al. 2017). The deficit could be reduced somewhat if: water losses were cut; groundwater resources were managed sustainably; and the consumption of those using more than 50 litres a day was reduced. In the absence of major improvements in water management, however, there are likely to be shortages and, given past experiences, these shortages are likely to amplify the other challenges to universal provision. Moreover, the assumptions underlying the modelling may be overly optimistic – for example, population growth rates could be higher than anticipated and there could be serious droughts. (Here is a link to a set of online charts illustrating the results of the modelling and how the shortages are affected by changes in water losses, groundwater use, population growth and imposing a lower limit of 50 litres a day on water consumption.)

Figure 7. Map of annual population growth rates in Dar es Salaam between 2002 and 2012



Map by Manja Hoppe Andreasen
Appears in Andreasen (2013)

3

The global challenge of universal water and sanitation coverage and the importance of local urban information and action

On the basis of a superficial look at the official statistics from monitoring the Millennium Development Goals, one could easily conclude that there is an urban bias in access to improved water and sanitation and that fighting inequality dictates that efforts to increase coverage be shifted from urban to rural areas. After all, with only 46 per cent of the world's population living in rural areas in 2015, rural areas contained an estimated 79 per cent of the population without improved water supplies and 70 per cent of the population without improved sanitation (WHO/UNICEF, 2015a). As detailed above, however, such statistics are misleading. Urban dwellers without adequate water and sanitation do not benefit from the fact that their better off co-residents bring up the urban shares. In any case, with continued urbanisation, the number of urban dwellers without improved water and sanitation have been growing, while the number of rural dwellers has been declining – trends likely to continue as urbanisation progresses. Importantly, such statistics incorrectly assume that if the same facilities are used in low density rural and high density urban areas, the resulting water and sanitation services are of the same quality. One of the reasons the sanitary revolution in the industrialising

countries of the 19th century occurred in cities is that low-cost water and sanitation technologies (e.g. shallow wells and pit latrines) and practices (e.g. open defecation) tend to be far more hazardous where there is urban crowding. When new efforts are initiated to support universal water and sanitation provision, it will be important to recognise that equity requires an ambitious urban as well as rural agenda.

The Sustainable Development Goals have recently been adopted. The targets include achieving universal water and sanitation coverage by 2030, and these targets are set alongside others involving shifts towards a more sustainable use of water resources, improved wastewater treatment and waste recycling, and better overall water governance (GEMI, 2016). As part of the shift from the MDGs to the SDGs, it looks as though the indicators for coverage ("improved" in the language of the MDGs, and "safely managed" in that of the SDGs) are going to be more rigorous, including, for example, additional information collected to check the quality of the water sources and the faecal sludge treatment. Done well, this could help to make the internationally estimated rural and urban coverage statistics more comparable. However, there will almost certainly still be problems with the new indicators. However, in setting a higher standard for acceptable water and sanitation provision, it will also be important to monitor progress up the ladder so as to ensure that striving for the best does not leave some groups behind.

In the main body of this paper, the emphasis has been on the limited local relevance of the international indicators developed for monitoring the MDGs. In short, a higher degree of international comparability has been bought at the cost of local relevance. The narrow focus on specific types and features of water and sanitation technologies, which at least seems to serve international comparability, hides these limitations. Many of the limitations arise because the same facilities can have very different consequences in different settings (e.g. rural versus urban). More generally, as illustrated with the case of Dar es Salaam, problems of water quality and supply reliability can arise with most of the water supply systems, and unsafe faecal sludge management can occur with most of the sanitation technologies. Ignoring these variations within what are presented as rungs on the water and sanitation ladder ignores some of the key inequalities in urban water and sanitation provision.

Another important limitation to local application arises because the international indicators are estimated primarily through questionnaire surveys administered to a statistically selected sample of households. These provide useful national averages for international monitoring, but do not provide statistics on specific urban settlements and cannot be used to identify where the deficient water and sanitation conditions are located within a settlement, which is central to guiding local improvement efforts. Census data are potentially far more useful for local action. They can complement the sort of community-driven efforts to document and improve water and sanitation described in Section 2.3. But these advantages are not tapped when, as is often the case, the census data do not include water and sanitation information, or the results are only presented as highly aggregated statistics, themselves more relevant to international monitoring than to local action. Despite the high census costs and the long intervals between censuses, it is easy to see how census data could become central to both international and local water and sanitation monitoring. It is also easy to see how some of the new information on water quality and wastewater treatment, to be gathered from local water providers and regulators for the new SDG water and sanitation targets, could serve local as well as international monitoring. To make both the census data and the information from utilities and regulators central to local action would, however, require strategic local investments.

A further limitation of the international indicators, at least as they are currently conceived, is that they do not take account of the preferences of those affected by the local water and sanitation inadequacies. One of the strengths of the community-created water and sanitation ladders described in Section 2.3 is that they build on local preferences and resident understandings of local conditions, rather than on a consensus of experts developed in meetings halfway across the world. One would not expect such ladders and definitions of acceptable provision to go unchallenged, nor to be available for all parts of Dar es Salaam, let alone the country as a whole. There may be legitimate technical or political reasons for challenging the community coproduced ladders. On the other hand, there are technical and political reasons for challenging the expert-produced ladders as well.

It is tempting to see the answer in an integrated set of nested indicators informing action at different levels – international, national, settlement, neighbourhood – with higher spatial resolution and more attention to user preferences at more local levels. However, this could quickly become ridiculously complicated and still not overcome the tensions between the different levels and their politics. One of the strengths of the community coproduced ladders and definitions of acceptability is that they potentially provide the communities with tools that they can call their own, and use when planning their own initiatives, negotiating with local authorities and, eventually, when coproducing improvements with local authorities or utilities. For community coproduced materials to play this sort of role, there needs to be organisations of the urban poor, and these organisations need both support and relative autonomy.

More generally, the appropriate agendas, indicators and aspirations at the local level depend on local conditions and how responsibilities for improvements are allocated, both formally and informally. The conventional model of piped water and sewage lends itself to publically regulated utilities taking overall operational responsibility, with well-defined targets and comparable standards. This model of piped water supply only applies to a small part of a city like Dar es Salaam, and this model of sewers with household connection applies to an even smaller part. In most of the city, residents and small private operators take most of the responsibility for sanitation facilities and for the last stage of water provision. The utility has a major role in operating and expanding the piped system, and NGOs and community-based organisations (CBOs) fill a variety of niches at the local level. An alternative model, sometimes presented as a new paradigm for low cost urban provisioning (Mara & Alabaster, 2008), would have a utility responsible for providing collective services – bringing water into the community, and taking away faecal sludge – but residents would take collective responsibility for improving local water and sanitation conditions on the basis of these services. In effect, communities would need to self-organise to operate the water distribution and sanitation services within their neighbourhoods. The alliance between CCI and TUPF could fit this model well, and some of the more successful urban examples of affordable sanitation improvement are based on such a combination of collective action and coproduction (McGranahan & Mitlin, 2016). The Tanzanian Ministry of Health's promotion of urban CLTS is also consistent with a move towards this model of coproduction (Ministry of Health, 2016; Myers, 2016).

The rapid and informal expansion of cities like Dar es Salaam provides further challenges for monitoring and supporting improvements in water and sanitation coverage. If the conventional vision for water and sanitation provision involves a publicly regulated utility, the conventional vision for linking water and sanitation provision to urban expansion involves providing basic services as plots are opened up for development. With informal development, the order is often reversed and unserviced plots are opened up informally, starting the new residents on a long term struggle for incremental service improvements, not only for water and sanitation, but for energy, transport and communications services too. As described in Section 2.4, this informal expansion in Dar es Salaam has strengths as well as weaknesses. There is little point in comparing the complex realities of informal expansion to an idealised system of formally planned expansion. On the other hand, authorities and utilities do have an important role to play in upgrading the process of expansion, and engaging with the process as one involving a complex system whose outcomes can be improved through reflective practice and adaptive management. This can be difficult when the state itself is under-resourced, poorly organised and prone to corruption, but in Dar es Salaam, as elsewhere, there are many opportunities for improvement – formalising key processes as and when this can be justified.

The water and sanitation challenges posed by informality and informal expansion in particular include not only those of ensuring adequate coverage, but also those of limiting the damage to water resources and the broader environment. In Dar es Salaam, the clearest example of this is groundwater use. The city's groundwater resources are not well documented, existing documentation is not readily available to those exploiting the groundwater resources (mostly informal borehole operators whose groundwater use is not well documented), and the many individual borehole operators have little incentive to protect these resources by curbing their own water abstraction. Two key objectives must be to avoid the uncontrolled depletion of the groundwater resources on the one hand, and to avoid measures prohibiting those most in need from accessing these resources on the other. This requires a balance that there is currently neither the information nor the institutional basis to achieve. Over the longer term, there are also contradictions between the expanding use of surface water and the sustainability of water resources in the water basins Dar es Salaam draws on.

What do these complex urban realities imply about international water and sanitation targets and monitoring? Clearly these complex realities – even just for urban areas – cannot be captured with internationally comparable indicators designed to monitor progress towards universal coverage. Moreover, it is highly misleading to present such indicators as accurate representations of local conditions, implicitly masking local complexity and misrepresenting not only how easily progress can be monitored, but how it can be achieved. The moves towards new water and sanitation ladders, and a new effort to collect more information on both water quality and excreta treatment and recycling, are steps in the right direction. However, it is also important to link the debate on targets, and how to monitor and achieve them, with more locally grounded efforts, including, for example, the locally generated water and sanitation ladders.

The maps and ladders produced at the community level reveal the complexity of water and sanitation provision and priorities in slums, and the incremental nature of progress that is not captured by global indicators. Federations of the urban poor use this data to secure funding and strategic relationships at the local level to improve water and sanitation services. When effective partnerships with sector stakeholders are established at the local level, the incremental nature of improvements are recognised as a strategy to improve provision. Such efforts complement or present intermediary solutions to the expansion of more traditional water and sanitation infrastructure planned in the longer term in a given city, and can contribute to the progressive realization of improved access. The question of how to ensure that the progress and priorities of low income communities can inform global monitoring processes requires further consideration, so that the sector can effectively represent and respond to the water and sanitation needs of low income urban settlements.

Acronyms

CCI	Centre for Community Initiatives
DAWASA	Dar es Salaam Water & Sewerage Authority
DAWASCO	Dar es Salaam water and sewerage corporation
SDI	Shack/Slum Dwellers International
TUPF	Tanzanian Urban Poor Federation

Related reading

Meeting future demand for drinking water supply in Dar es Salaam: hydrological modelling of the Ruvu River and assessment of flows, Joel Nobert and Jamie Skinner. (2016) IIED Working paper

How collective action strategies of the urban poor can improve access to sanitation, Anna Walnycki, Noah Schermbrucker, et al., (2016), Sanitation and Hygiene Applied Research for Equity (SHARE) Consortium report

Financing universal access to sanitation – lessons from Four African cities, Noah Schermbrucker, Anna Walnycki, et al. (2016), Sanitation and Hygiene Applied Research for Equity (SHARE) Consortium report

Interrogating community-led strategies for sanitation provision at scale in South Africa, Andy Bolnick (2016), Sanitation and Hygiene Applied Research for Equity (SHARE) Consortium report

Why is water still unaffordable to the urban poor? Diana Mitlin and Anna Walnycki (2015) IIED Briefing Paper

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Realising the right to sanitation in deprived urban communities: meeting the challenges of collective action, co-production, affordability, and housing tenure, Gordon McGranahan (2015), World Development, Vol 68, pages 242–253

Sharing reflections on inclusive sanitation, Evans Banana, Chisomo Harawa et al. (2015), Environment and Urbanization (subscription required)

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Global targets such as the Sustainable Development Goals and associated monitoring play a key role in supporting efforts to move towards universal access to water and sanitation. Reflecting on Dar es Salaam, Tanzania, this paper demonstrates how global monitoring often fails to reflect and support local efforts to improve water and sanitation in low-income settlements. Locally generated water and sanitation data and perceptions of progress can reveal important realities of water and sanitation provision that global monitoring inadvertently conceals. Global targets and indicators need to be balanced with locally grounded knowledge to usefully support efforts to move towards universal access.

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