The Sustainable Development Goal for Urban Sanitation: Africa's Statistical Tragedy Continues?

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Abstract Sanitation delivery in the urban areas of sub-Saharan African countries has been a chronic issue, particularly difficult to tackle. Under the Millennium Development Goals, the sanitation target in urban sub-Saharan Africa was missed by a wide margin and witnessed almost no improvement. After 2 years of review, the WHO/UNICEF Joint Monitoring Programme published a new measure of access to sanitation as a baseline for the Sustainable Development Goals. There are a number of improvements in the new measure. However, despite the improvements, the new measure continues to be characterized by an important flaw: it continues to disregard how shared toilet facilities contribute towards the SDG sanitation target. As a result, the new measure does not indicate whether progress is being made in low-income urban areas where a large number of households rely on shared sanitation; nor does it provide a goal that can be achieved in cities of the poorest countries over the measurement period. But, its most egregious failing is that it directs resources towards investments which will often fail cost/benefit tests. In sum, it is not a surprise that a Working Group recommended

that the measure should be changed to include some shared facilities. Following the Working Group's recommendation would have avoided the adverse consequences of continued reliance on a key component of the methodology used for monitoring sanitation improvements under the Millennium Development Goals. The paper discusses the limitations of this methodology in the context of urban sub-Saharan Africa, where current sanitation conditions are seriously lacking, and the significant future urban population growth will add more pressure for the delivery of vital sanitation services.

Keywords Sustainable Development Goals · Sub-Saharan Africa · Urban sanitation · Data · Donors

Introduction

Most urban residents in sub-Saharan Africa (SSA) lack access to basic sanitation. The costs of this situation in terms of health, productivity, and loss of dignity are extraordinary, with a massive disease burden associated with deficient hygiene, sanitation, and water supply [1, 2]. At present, only 41% of urbanites have access to individual household latrines [3], and more than half of the urban population lives in slums [4], where sanitation conditions are seriously lacking and facilities are often shared among households. More importantly, according to the measurement made for the Millennium Development Goals (MDGs), over the past 25 years, sanitation conditions in urban areas of the region have improved only slightly, by only two percentile points and from a very low baseline [3]. Most of these improvements were the result of the increased use of septic tanks, as the share of urban

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population with access to sewer connections in urban SSA has actually decreased from 13% in 2000 to 11% in 2015. Many of the cities in which the share of the population in slums increased also had increasing per capita incomes [5], suggesting a historical parallel with Britain during the mid-nineteenth century, where economic growth alone did not contribute to improved health but rather posed critical challenges to health and welfare [6].

The WHO/UNICEF Joint Monitoring Programme (JMP) recently published a new approach to the measurement of access to sanitation for use in the Sustainable Development Goals (SDGs) [3]. The new measure shows just how complicated it is to monitor access to sanitation in urban areas: quantifying the number of people with such access goes beyond measuring individual behavior, to concerns about how safely excreta are managed and treated. JMP's new approach demonstrates considerable sensitivity to these broader measurement issues by adopting a new system for the monitoring of sanitation conditions making it now possible to disaggregate and evaluate sanitation access according to different rungs of a ladder. According to this new framework, the JMP now divides improved sanitation facilities into three categories: limited, basic, and safely managed services. The population using improved facilities that are shared with other households is now being called limited rather than shared. Individual facilities are categorized as either basic or safely managed services, depending on how excreta are managed.

However, on the core measurement issue—whether facilities used by more than one household count towards fulfilling the SDG sanitation target—JMP rejected the recommendations of its Working Group [7]. In particular, JMP rejected the Working Group's recommendation that facilities shared by the lesser of either five families or < 30 people who are known to each other should also be considered as at least basic sanitation services. Instead, its new measure calls for a continuation of the use of individual household units representing access to basic sanitation. As a result, shared facilities, such as those used by more than one third of sub-Saharan Africa's (SSA) urban residents, are now considered to provide limited improvements to sanitation, but do not contribute to the SDG sanitation target [8].

This decision has elicited a debate. Some authors argue that the definition should be changed to include some types of shared facilities [9–11]. Others say that considerable caution is warranted in such broadening of the definition [12, 13].

The objective of this paper is to discuss the implications of the current definition for measuring access to sanitation in the case of urban SSA, a rapidly urbanizing region with very low levels in access to sanitation. We show that when the empirical results are carefully examined, the evidence does not support the claim that sharing a sanitation facility with just one to two other households can increase the risk of “moderate to severe diarrhea” in young children [14]. Nor does the argument for caution imply that considering shared facilities invalidates the recommendation of the Working Group.

But more than disputing the evidence in support of the JMP decision, we also show that this decision will likely lead to the following:

- A goal that is almost certainly beyond the reach of most of the poorest countries over the SDG period
- Sanitation investments that fail traditional cost-benefit analysis for urban SSA
- The misdirection of donor sanitation assistance
- The use of a measure that provides little information about performance on the goal, especially in low-income urban areas of low-income countries, where better monitoring of the performance is necessary

Cumulatively, when these failings are considered, the rejection of the Working Group recommendation appears to be a case of the “Poor Numbers” [15] that characterize data collection in much of sub-Saharan Africa, a process that results in what has been referred to as “Africa's statistical tragedy” [16]. In this perspective, the tragedy occurs because donors undertake “statistical activities...they need data for their own purpose—to publish reports...” [17].

The plan of the paper is as follows. The next two sections consider the conceptual and empirical evidence on the various measures. Then, “[The Cost and Benefits of Sanitation Investments and Donor Perspectives](#)” details how the investments implied by JMP's definition fail cost-benefit tests and are likely to adversely affect international aid. The final section concludes with a discussion of the future implications of the current sanitation measure in light of the expected demographic prognostications for urban SSA.

Evidence on the Definition of Access to Basic Urban Sanitation

JMP's position is that shared facilities do not constitute improvements towards the SDG sanitation target. Perhaps, the main problem with this approach is that it sets the quality bar too high. For example, many shared facilities are indeed sanitary but do not count as basic. For example, in a recent study, 75% of facilities in Kampala's slums shared by four or fewer families were found to be sanitary [18]. A similarly high share of shared facilities was found to be sanitary according to the 2016 South African General Household Survey [19], while another study [20] found that in Dar es Salaam, shared facilities were often more sanitary than individual units. It is clear, then, that there is considerable heterogeneity across places [21]. As a result, there is no simple way to simply add shared facilities to the JMP estimated indicator of individual units to solve this shortcoming.

However, heterogeneity across service levels does not imply that the quality of service offered by shared facilities is likely to be as high as it is with individual units. For example, beyond a certain number of users, the physical cleanliness of facilities declines sharply [18]. For instance, in the case of Harare, ecosan toilets shared among five households or more proved difficult to maintain [22]. This has been also supported by a recent study which concluded that compared to private sanitation facilities, all shared facilities should continue to be classified as 'unimproved' for monitoring global sanitation [14]. However, the median number of people sharing a facility in this analysis is 45, 50% more than the ceiling of 30 people recommended by the JMP Working Group. The same study found that sharing between two households did not have a significant effect on the incidence of diarrhea.

JMP's concern that counting shared facilities would lower standards has also been supported by another recent meta-analysis that found that the odds of experiencing diarrhea are considerably higher with shared units than they are with individual facilities [12]. However, when adjustment is made for confounding variables, shared sanitation was a statistically significant risk factor in only one country, and in only two of the nine studies examined were facilities shared by fewer than five families or 30 people—as per the working group recommendation—and of these, one found no discernible effect of sharing.

Hence, the evidence provides little support for the JMP rejection of the Working Group's recommendation. As expected, the results show that the likelihood of

unsanitary conditions with individual units is likely to be lower and that there is a positive correlation between diarrhea incidence and the number of users. Nevertheless, because the two types of facilities cannot be simply aggregated does not mean that shared units should not be counted towards the goal if indeed, they are sanitary.

Moreover, too high a standard is not the only problem with the current measure: it simultaneously sets the bar too low. For sanitation services to achieve broader health effects, behavior at both the community level as well as at the household level matters. According to a meta-analysis of 22 studies of the effect of neighborhood and household conditions on diarrhea morbidity, neighborhood sanitation conditions are associated with a similar magnitude of reduction in diarrhea morbidity as are household conditions [23]. There also appears to be a "herd protection" neighborhood effect that accounts for a substantial portion of the total protection provided by sanitation interventions [24]. As we show below, the literature suggests that for sanitation interventions to be effective, such herd protection—i.e., widespread availability of services—must be present. Unfortunately, many studies, like the proposed SDG measure, fail to account for these neighborhood effects and, thus, focus too narrowly on the improvements yielded by individual units.

Perhaps the only serious, and admittedly not well-defined, estimates of the level at which community participation achieves beneficial neighborhood or herd effects come from two somewhat dated studies [25, 26]. Both studies argue that if service provision falls below 75% of community members, provision by more individual units will not result in a healthier environment. A more recent study confirms these earlier estimates and shows that half of the potential total sanitation health gains are reached only when sanitation coverage reaches approximately 75% of the community [27]. That is, when less than 75% of a community has access to sanitary units, even those with access to individual facilities remain at risk. Unless the provision of individual units exceeds the threshold for general improvement—clearly an uncertain level, but also one that is almost certainly well above the average of 40% now reached by SSA's cities—the measured improvements do not result in better conditions.

In addition, there may be another adverse neighborhood effect that is not captured even by measures that pay attention to the neighborhood effects that can mitigate the positive contributions of individual units. That is, rather than contributing to neighborhood health, new

individual units can, in fact, impose increased costs for the rest of a neighborhood. For example, when water closets were first introduced into British cities in the nineteenth century, health conditions deteriorated as the property owners installed the closets [6]. In the absence of the kind of a safe removal system—of the sort now emphasized by the new JMP measure—waste was allowed to empty into the nearest water source, polluting drinking water. As a result, “The lethal lesson was ...that selective sanitation for the upper classes alone was not a sufficient panacea in the prevention of water-borne disease” [6] (p. 21). That is, whether the facilities are shared or not, if the waste is not safely removed and treated, neither sort of facility can be counted upon to have beneficial health effects. Particularly in urban SSA where most individual units rely on on-site storage for excreta management, and only 11% of the population is connected to sewer networks, accounting for improvements is very difficult. Furthermore, for SSA, unlike most other regions, there is no obvious way to measure whether appropriate steps are being carried out as data on whether excreta are being safely managed exists only for 8% of the SSA countries [3]. Hence, it is problematic whether this information gap will be filled in the near term.

In sum, the empirical evidence does not provide strong support for the use of the current definition. What about the logic of the approach? Does it lead to better decision-making or resource allocation?

The Definition Sets an Unrealistic Goal for Many Countries

To consider how the current measure affects the ability of SSA countries to fulfill the sanitation SDG, consider the share of urban residents with access to improved sanitation and their income levels. This perspective suggests whether a minimum income threshold might be constraining the ability to purchase what JMP defines as access to at least basic sanitation. Figure 1 plots out the performance on JMP’s measure of improved urban sanitation (under the SDG framework, the measure has been renamed “At least basic” sanitation) in 2015—the closing year of the MDG monitoring framework—and the per capita income levels for SSA countries. It indicates that there is a bunching of observations at low levels of access for countries with low per capita income. With the exception of Senegal, all countries

defined by the World Bank as having either a low-income level, i.e., less than \$1045, or lower-middle-income level, up to \$4125, provide improved urban sanitation services for less than two thirds of the urban population and in many cases, less than one third. That is, with one exception, countries with low and lower-middle per capita income have limited access to improved sanitation. In contrast, for countries in the upper middle-income and high-income brackets, four of the eight countries have high levels of access to improved urban sanitation.

Thus, perhaps the main point of the figure is that levels of income rather than just changes in it matter. That is, below some income level, most people cannot afford individual units. In terms of the demand for the kind of sanitation services JMP describes as basic, the figure shows that demand depends upon more than just the income elasticity as is usually assumed to be the case in studying the demand for durable goods. That is, below a threshold income level, increases in income do not lead to increases in demand.

In many respects, this result should not be surprising as an unshared unit, by definition, involves at least twice the initial expenses as does one that is shared by more than one household. Moreover, incomes in the lower-income and lower-middle-income SSA countries are one third the average of those in the upper-middle-income SSA countries. At the very least, then, investing in an individual facility in a low-income or lower-middle-income SSA country requires three times more of the average household’s income than it would in an upper-middle-income SSA country. Even if the family in a low-income country shared a toilet with only one other family, it would still require that family to pay 50% more of its income than was the case in the upper-middle-income country. In such a context, it is not surprising that households in lower-income quintiles of low-income countries often have to pay a significant share of income for water and sanitation services [28].

To put this argument another way, the figure suggests why it is not surprising that in 2015 more than 130 million African urban residents relied on shared toilet facilities. Many of the households who share facilities are in the middle class of their respective countries, rather than poor as would be the case in countries with higher-income levels [21]. The reasons are two: first, SSA contains most of the low-income countries—27 out of 31 countries so categorized by the World Bank; and second, most families in these countries—not just

Fig. 1 Share of urban population with access to improved sanitation and GDP per capita in sub-Saharan African countries.

Source: JMP (2015a) International Monetary Fund (IMF) World Economic Outlook (WEO) (2015)

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the lowest-income families—have relatively lower incomes and so are unable to afford individual facilities.

But, not only can most African households not afford JMP's notion of basic sanitation provided through an individual unit, they will not be able to do so for a long time. For instance, Fig. 1 shows that in 35 countries, the share of improved users is below the level at which broader welfare gains are thought to be realized—say at least 65% of the households in a neighborhood. If the income levels in these countries are compared with the income levels at which the neighborhood health effects are generally achieved, i.e., the figure suggests about \$7000, we find that it will take a considerable amount of time to reach that income level. Indeed, using JMP's measure, in many SSA countries, it is unlikely that progress will be made on this SDG indicator for a generation or more, well beyond the SDG measurement period of 15 years. Thus, the SDG for urban sanitation sets a target that almost certainly dictates failure for many countries.

The Cost and Benefits of Sanitation Investments and Donor Perspectives

But, perhaps the most egregious failing of the new measure is that it will misdirect attention to low return investments. For instance, a recent, global study on the costs and benefits of water sanitation and hygiene [29] implies that the JMP definition will encourage sanitation investments that fail cost-benefit analysis. The study presents benefit-cost

ratios for investment in sanitation for the different regions, and locations, and finds a benefit-cost ratio for urban facilities in SSA of 1.2. However, this estimate assumes 2.5 families share each facility. Interestingly, this estimate seems to align with current sanitation improvement interventions in low-income urban areas that involve sharing between landowners and tenants occupying one plot [22]. If instead of sharing these costs across 2.5 families, these costs were incurred by a single household, as is required in order to fulfill JMP's definition to have access to basic sanitation, costs would increase by 150%. With these higher costs, the corresponding benefit-cost ratio for individual units would fall to .8. That is, the type of investments that fulfill the JMP goal would fail traditional benefit-cost calculations.

It is important to note that the above calculation ignores the time of waiting costs which in some instances can account for a significant reduction in benefits [30]. However, for a number of reasons, considering these costs for the limited number of users recommended by the Working Group is unlikely to lead to a change in the cost-benefit calculus. For example, for the East Asian countries where congestion costs were disaggregated, the highest time costs for the additional congestion came largely from the case of Indonesia. In this case, facilities were shared with 100 users, more than three times the largest size recommended by JMP's Working Group. In addition, that study also stresses that the opportunity costs of this reduction in benefits are driven by the per capita income of the facility users. It assumes, for instance, that the costs of the time spent

waiting were equal 30% of the average wage for the waiting time in the respective countries. The per capita income of SSA countries is only slightly more than half that of the Indonesia, so that the waiting costs would be much less than the 19% that occurred in Indonesia with its much higher income and group size. Hence, the waiting time for shared units in urban SSA would have considerably less of an adverse effect on the benefits gained from individual units. Thus, even when adjustments are made for the reduced benefits implied by the congestion of shared facilities, it is still unlikely that individual SSA facilities would pass benefit-cost investment tests.

The failure of the SDG measure to be able to pass generic cost-benefit tests is also important because it will affect the level of aid flows to specific countries. Donors, such as USAID [31] and DFID [32], use the SDG measure to report on the effectiveness of their efforts. In addition, organizations such as the World Bank and the Mo Ibrahim Foundation use the JMP data in their measures of governance [33]. These governance measures, in turn, are used as broader indicators of places where aid can be used effectively. Hence, as long as aid distributions are made based on JMP's measure that indicates progress in the fulfillment of the sanitation SDG, less will go to those who need it most and who may well be making significant progress on sanitation conditions.

Conclusion

How, then, does the SDG measure compare with the alternative posed by the JMP Working Group? Our analysis concludes that the measure's continued reliance on individual units as the threshold for basic access provides neither a good measure of performance, nor does it yield information on whether performance has improved. Nor does the empirical evidence support JMP's rejection of the Working Group's recommendation to broaden the definition of access to basic urban sanitation. This position is particularly important for SSA where shared facilities are common. Certainly, the recognition of shared facilities as representing a limited improvement is a step forward; nevertheless, this change does not address many of the shortcomings of the earlier MDG measure of improved sanitation.

As a result, we fear that the current measure will have pernicious effects: it will waste resources, adversely

affect aid flows, and provide an aspirational goal that will be unreachable for many countries. Moreover, it is important to consider the policy environment in which these benchmark measures are being made. Most of the SSA urban population already lives in slums which are often growing faster than the city population [4]. These slums already have health outcomes that are significantly worse than elsewhere in the cities and, on some measures, significantly worse than rural areas [34].

This already under-served, and less healthy population will increase by over 250 million people in the 15 years of the SDG measurement period, and, again, the region has shown almost no improvement in access to basic sanitation conditions over the last 25 years. Indeed, the absolute number without access to basic sanitation in SSA cities has increased by almost 40 million since 1990, and almost 16 million more SSA urban residents now engage in open defecation, than did so 25 years ago [35]. In sum, SSA's cities are operating in a very difficult policy environment.

In this light, JMP's rejection of the recommendation of its Working Group follows a data development path that is not only irrelevant, but is also tragic. Other expert observers, in an earlier multi-donor Water and Sanitation Program study, all agree with the Working Group that a more flexible standard is appropriate [9–11]. Without a change in its position, the new measure will not be a disinterested effort to come to grips with an important but difficult to measure concept. It will be yet another African statistical tragedy.

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References

1. Prüss-Üstün A, Bos R, Gore F, Bartram J. Safer water, better health - costs, benefits and sustainability of interventions to protect and promote health. *Geneva, Switzerland: World Health Organization (WHO)*; 2008.
2. Bartram J, Cairncross S. Hygiene, sanitation, and water: forgotten foundations of health. *PLoS Med.* 2010;7(11): e1000367. <https://doi.org/10.1371/journal.pmed.1000367>.

3. World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines. Geneva, Switzerland: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF); 2017. Licence: CC BY-NC-SA 3.0 IGO.
4. Lall SV, Henderson JV, Venables A. *Africa's cities: opening doors to the world*. Washington, D.C: International Bank for Reconstruction and Development, The World Bank; 2017.
5. Marx B, Stoker T, Suri T. The economics of slums in the developing world. *J Econ Perspect*. 2013;27(4):187–210.
6. Szreter S. The importance of social intervention in Britain's mortality decline c. 1850–1914: a re-interpretation of the role of public health. *Soc Hist Med*. 1988;1(1):1–38.
7. WHO/UNICEF Joint Monitoring Programme for Water-supply and Sanitation. *JMP Green Paper: global monitoring of water, sanitation and hygiene post-2015*. https://www.wssinfo.org/fileadmin/user_upload/resources/JMP-Green-Paper-15-Oct-2015.pdf. Accessed February 4, 2018.
8. Morella E, Foster V, Banerjee SG. *Climbing the ladder: the state of sanitation in sub-Saharan Africa. Backgr Pap*. Washington, D.C: International Bank for Reconstruction and Development, The World Bank; 2008;13. <http://microdata.worldbank.org/index.php/citations/2969>.
9. Mara D. Shared sanitation: to include or to exclude? *Trans R Soc Trop Med Hyg*. 2016;110(5):265–7. <https://doi.org/10.1093/trstmh/trw029>. Accessed January 12, 2018.
10. Hawkins P, Blackett I, Heymans C. *Poor-inclusive urban sanitation: an overview*. 2013. <https://www.wsp.org/sites/wsp.org/files/publications/WSP-Poor-Inclusive-Urban-Sanitation-Overview.pdf>. Accessed November 29, 2017.
11. Rheinländer T, Konradsen F, Keraita B, Apoya P, Gyapong M. Redefining shared sanitation. *Bull World Health Organ*. 2015;93(7):509–10.
12. Heijnen M, Cumming O, Peletz R, et al. Shared sanitation versus individual household latrines: a systematic review of health outcomes. In: Baradaran HR, editor. *PLoS ONE*. 2014;9(4):e93300. <https://doi.org/10.1371/journal.pone.0093300>.
13. Tamboura B, Baker KK, Sow SO, Kotloff KL, Doumbia M, Nataro JP, et al. Quality of piped and stored water in households with children under five years of age enrolled in the Mali site of the Global Enteric Multi-Center Study (GEMS). *Am J Trop Med Hyg*. 2013;89(2):214–22. <https://doi.org/10.4269/ajtmh.12-0256>.
14. Baker KK, O'Reilly CE, Levine MM, Kotloff KL, Nataro JP, Ayers TL, et al. Sanitation and hygiene-specific risk factors for moderate-to-severe diarrhea in young children in the global enteric multicenter study, 2007–2011: case-control study. *PLoS Med*. 2016;13(5):e1002010.
15. Jerven M. Comparability of GDP estimates in Sub-Saharan Africa: the effect of revisions in sources and methods since structural adjustment. *Rev Income Wealth*. 2013;59:S16–36. <https://doi.org/10.1111/roiw.12006>.
16. Devarajan S. Africa's statistical tragedy. *Rev Income Wealth*. 2013;59:S9–S15. <https://doi.org/10.1111/roiw.12013>.
17. Devarajan S. *Africa's statistical tragedy*. Afr End Poverty. October 2011. <http://blogs.worldbank.org/african/africa-s-statistical-tragedy>. Accessed January 13, 2018.
18. Günther I, Niwagaba CB, Lüthi C, Horst A, Mosler H-J, Tumwebaze IK. *When is shared sanitation improved sanitation?—the correlation between number of users and toilet hygiene*. ETH Zurich, 2012.
19. *Statistics South Africa General household survey 2016*. Statistics South Africa; 2016. <http://www.statssa.gov.za/publications/P0318/P03182016.pdf>. Accessed January 13, 2018.
20. Jenkins M, Cumming O, Scott B, Cairncross S. Beyond 'improved' towards 'safe and sustainable' urban sanitation: assessing the design, management and functionality of sanitation in poor communities of Dar es Salaam. *Tanzania J Water Sanit Hyg Dev*. 2014;4(1):131–41.
21. Heijnen M, Rosa G, Fuller J, Eisenberg JN, Clasen T. The geographic and demographic scope of shared sanitation: an analysis of national survey data from low-and middle-income countries. *Tropical Med Int Health*. 2014;19(11):1334–45.
22. Banana E, Chikoti P, Harawa C, McGranahan G, Mitlin D, Stephen S, et al. Sharing reflections on inclusive sanitation. *Environ Urban*. 2015;27(1):19–34.
23. Jung YT, Hum RJ, Lou W, Cheng Y-L. Effects of neighbourhood and household sanitation conditions on diarrhea morbidity: systematic review and meta-analysis. *PLoS One*. 2017;12(3):e0173808.
24. Fuller JA, Eisenberg JN. Herd protection from drinking water, sanitation, and hygiene interventions. *Am J Trop Med Hyg*. 2016;95(5):1201–10.
25. Esrey SA. Water, waste, and well-being: a multicountry study. *Am J Epidemiol*. 1996;143(6):608–23.
26. Bateman OM, Smith S. *A comparison of the health effects of water supply and sanitation in urban and rural Guatemala*. In: *Institute for Resource Development, editor. Proceedings of the Demographic and Health Surveys World Conference, Washington, USA*. Columbia, MD: Institute for Resource Development. 1991. vol. 2, p. 1505–1524.
27. Wolf J, Hunter PR, Freeman MC, Cumming O, Clasen T, Barttram J, et al. Impact of drinking water, sanitation and handwashing with soap on childhood diarrhoeal disease: updated meta-analysis and meta-regression. *Tropical Med Int Health*. 2018;23(5):508–25.
28. Smets H. Quantifying the affordability standard: a comparative approach. In: Langford M, Russell A, editors. *The human right to water: theory, practice, and prospects*. Cambridge, UK: Cambridge University Press; 2014.
29. Hutton G. *Benefits and costs of the water sanitation and hygiene targets for the post-2015 development agenda*. *Post-2015 Consensus Working Paper Series*. Tewksbury, MA: Copenhagen Consensus Center; 2015.
30. Napitupulu L, Hutton G. *Economic impacts of sanitation in Indonesia: a five-country study conducted in Cambodia, Indonesia, Lao PDR, the Philippines, and Vietnam under the Economic of Sanitation Initiative (ESI)*. Jakarta: Water and Sanitation Program. East Asia Pac World Bank Off Jkt; 2008.
31. USAID. *Sanitation: water and development strategy implementation brief*. GLOBALWATERS.ORG (Beta). <https://www.globalwaters.org/node/129>. Published September 16, 2016. Accessed January 13, 2018.

32. Indicator Methodology Notes (annex to DFID's Results Framework setting out how DFID measures results). - GOV.UK. <https://www.gov.uk/government/publications/indicator-methodology-notes>. Accessed January 13, 2018.
33. WHO/UNICEF. Report of the first consultation on post-2015 monitoring of drinking-water and sanitation. 2011. <https://washdata.org/report/jmp-2011-berlin-consultation-post2015>. Accessed January 13, 2018.
34. Günther I, Harttgen K. Deadly cities? Spatial inequalities in mortality in sub-Saharan Africa. *Popul Dev Rev*. 2012;38(3): 469–86.
35. WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. JMP. Joint Monitoring Programme. <https://washdata.org/data>. Accessed January 13, 2018.