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Refreshing Africa's future

Prospects for achieving universal WASH access by 2030

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Summary

Access to water, sanitation and hygiene is indispensable to development, but what will it take for Africa to achieve universal access in 15 years? This paper uses the International Futures forecasting system to explore Sustainable Development Goal 6, which promises water, sanitation and hygiene to all by 2030. It finds that Africa is not on track to meet this goal. In response, it uses two alternative scenarios to assess the costs and benefits associated with accelerating access. The first models an aggressive push toward universal access and the second a more moderate approach that advances access to water, sanitation and hygiene based on countries' 2015 baselines.

THIS PAPER EXPLORES Africa's potential to meet the first two targets of Sustainable Development Goal (SDG) 6: universal and equitable access to safe water, adequate sanitation and hygiene (WASH) by 2030. It uses the International Futures (IFs) forecasting system[1] to look at Africa's current trajectory (Current Path), along with two additional scenarios that model strategies for improving access to water and sanitation above the Current Path. The first scenario (Universal Access) models an aggressive push toward universal access in accordance with targets 6.1 and 6.2 of the 2030 Agenda for Sustainable Development. The second scenario (Balancing WASH) is a more moderate approach that focuses on advancing the targets based on countries' 2015 baselines. This analysis will consider the costs of both interventions, along with their benefits to development.

In the Universal Access scenario, water access in Africa grows at an average annual rate of 2.0 percentage points and sanitation at a rate of 3.7 percentage points. Only three countries in the world achieved a growth rate of 2.0 percentage points or above for water access under the MDGs, and the sanitation growth rate in this scenario exceeds the MDG-growth record of 2.9 percentage points annually.[2] This scenario also suggests that, even with historically high growth in access, many African countries are still unlikely to meet the target for sanitation given their low 2015 baselines.

The Universal Access scenario furthermore reveals that achieving universal WASH access will require African countries to make investments in infrastructure that go far beyond what is expected on Africa's Current Path. This scenario forecasts a cumulative increase in infrastructure spending

of over US$122 billion (all monetary values in this report are in 2011 US dollars) from 2016 to 2030. Moreover, achieving targets 6.1 and 6.2 implies significant domestic spending trade-offs, unless countries can mobilise sufficient resources from alternative sources. These trade-offs could compromise progress in other areas. Finally, an examination of key human development variables indicates that the countries with the lowest access have the most to gain from spending on WASH, but will also absorb the vast majority of resources.

> WASH is an area that has received more attention from the international community in the post-2015 agenda

The Balancing WASH scenario models a future in which resources for WASH are not sufficient for countries to reach universal access by 2030. This scenario has access growing at a lower rate (1.1 percentage points annually for water and 1.6 for sanitation), and emphasises the importance of prioritising spending on SDG 6 in low-access countries. These countries see a significant improvement in WASH-related human development outcomes even without reaching targets 6.1 and 6.2 by 2030, in the order of 50% of the impact for around 30% of the cost (US$36 billion).

This paper is part of the African Futures Project (AFP).[3] The AFP is an ongoing collaboration between the Institute for Security Studies and the Frederick S. Pardee Center for International Futures at the University of Denver. The partnership promotes the exploration and identification of trends and policy interventions to advance human development and sustainability.

Background

In September 2015 the United Nations (UN) passed Resolution 70/1, which outlined the 2030 Agenda for Sustainable Development. This new 'post-2015 agenda' reaffirms the commitment the organisation made to eradicating global poverty 15 years earlier in the Millennium Development Goals (MDGs), and includes 17 SDGs with 169 associated targets. The SDGs reiterate a number of objectives from the Millennium Development Agenda, such as ending hunger and eliminating poverty 'in all its forms everywhere.'[4] They also expand upon the MDGs to incorporate goals and targets that cover ancillary drivers of human development and wellbeing, such as responsible consumption and production and reduced inequalities.[5]

WASH is an area that has received more attention from the international community in the post-2015 agenda. MDG 7 included a WASH target that aimed to 'halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation,' but it was nested within a much broader goal that intended to 'ensure environmental sustainability.'[6] In the SDG agenda, WASH has been given an independent goal (SDG 6) that aims to 'ensure availability and sustainable management of water and sanitation for all.'[7] SDG 6 departs from MDG 7 in its two primary targets (6.1 and 6.2), first by calling for *universal* access to safe drinking water and adequate sanitation by 2030, second by including hygiene with its sanitation target and third by highlighting the need for *equitable* access, focusing on the needs of women, girls, and those in vulnerable situations.[8]

Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all

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

Most African countries were unable to meet MDG 7's WASH target, and are entering the SDG period with inauspiciously low baselines in WASH access. This paper uses IFs to first examine the trajectory of targets 6.1 and 6.2 of the SDGs to 2030 on Africa's Current Path.[9] It then explores two alternative scenarios that model potential futures for Africa in which access rises above the Current Path. The first is the Universal Access scenario, which explores the costs and benefits of striving to meet targets 6.1 and 6.2 in Africa over the next 15 years. The second is the Balancing WASH scenario, in which countries pursue these targets more or less aggressively in the context of limited resources, basing decisions on their current level of access and the relative potential of SDG 6 to complement other national development objectives.

Data and definitions

The UN officially recognised the World Health Organization (WHO) and the UN Children's Emergency Fund's (UNICEF) Joint Monitoring Programme (JMP) as the 'formal instrument' for

measuring water and sanitation access under the MDG framework.[10] The WHO/UNICEF JMP began monitoring access in 1990, and will likely remain the world's primary source of water-and sanitation-access data through the end of the SDG period. IFs follows this convention, using the most recent publicly available data from JMP for analyses and forecasts.[11] This dataset includes annual access data for most countries from 1990 to 2015, disaggregated by improved, unimproved, and shared water sources and sanitation facilities.[12]

Safe water

The JMP defines safe water as water that comes from either shared or private improved drinking water sources. An 'improved' source of drinking water is, 'one that by the nature of its construction and when properly used, adequately protects the source from outside contamination, particularly faecal matter.'[13] This includes piped water, wells, boreholes, and natural water sources that are adequately protected from environmental contaminants.[14] This paper uses the terms 'safe' and 'improved' interchangeably when referring to water access.

Adequate sanitation

Access to improved sanitation, as defined by the JMP, is more limited than water by virtue of it excluding shared facilities.[15] The JMP defines an adequate, or 'improved,' sanitation facility as one 'that hygienically separates human excreta from human contact.'[16] This paper uses the terms 'adequate,' 'improved,' and 'basic' interchangeably when referring to sanitation access. Table 1 has a complete list of the distinctions made by the JMP with respect to improved and unimproved sources of drinking water sources and sanitation facilities.

Table 1: Improved and unimproved water sources and sanitation facilities

Drinking water sources		Sanitation facilities	
Improved drinking water	Piped water into dwelling Piped water to yard/plot Public tap or standpipe Tubewell or borehole Protected dug well Protected spring Rainwater	Improved sanitation	Flush toilet Piped sewer system Septic tank Flush/pour flush to pit latrine Ventilated improved pit latrine (VIP) Pit latrine with slab Composting toilet Special case (flush toilet with unknown piped connection)
Unimproved drinking water	Unprotected spring Unprotected dug well Cart with small tank/drum Tanker-truck Surface water Bottled water	Unimproved sanitation	Flush/pour flush to elsewhere Pit latrine without slab Bucket Hanging toilet or hanging latrine Shared sanitation No facilities or bush or field (i.e. open defecation)

Source: WHO/UNICEF, Joint Monitoring Programme: Improved and Unimproved Water Sources and Sanitation Facilities, 2016, www.wssinfo.org/definitions-methods/watsan-categories/.

Measuring hygiene

In 2012 the JMP led the formation of the Post-2015 Working Group on Hygiene to address the challenge of systematically measuring good hygiene, which the JMP recognises as 'fundamental to good health, dignity and quality of life'.[17] The group identified handwashing, food hygiene and menstrual hygiene management as the three most critical components of good hygiene, and began to define the criteria for targets and indicators that could be used to monitor hygiene over time and across countries.[18] A formalised monitoring framework for hygiene has not yet been established despite its explicit inclusion in SDG target 6.2, however. Instead, hygiene continues to be treated as an implicit outcome of access to improved water sources and sanitation facilities.

WASH and sustainable development

The inclusion of WASH access as a discrete goal in the 2030 Agenda for Sustainable Development makes clear the critical need that many still have for reliably safe water sources, access to adequate sanitation, and improved hygiene. At the closing of the MDG cycle, 663 million people (9% of the world's population) still lacked access to improved drinking water globally, while 2.4 billion (32% of the world's population) lacked access to basic sanitation services.[19] It also recognises WASH's critical importance to human health and wellbeing.

> Water and sanitation are core infrastructure improvements that are critically important to advancing economic and social development

This paper adopts the view that the post-2015 agenda is an integrated approach to inclusive development. In this sense, targets 6.1 and 6.2 must be considered within the broader context of the SDGs. These targets are important not only because they have an immediate impact on quality of life, but also because they affect other areas of development. For example, if children do not have access to clean water and improved sanitation, they are more vulnerable to diarrhoeal disease. Diarrhoeal disease can cause children to regularly miss schooldays, making it difficult to achieve SDG 4's first target: 'By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.'[20]

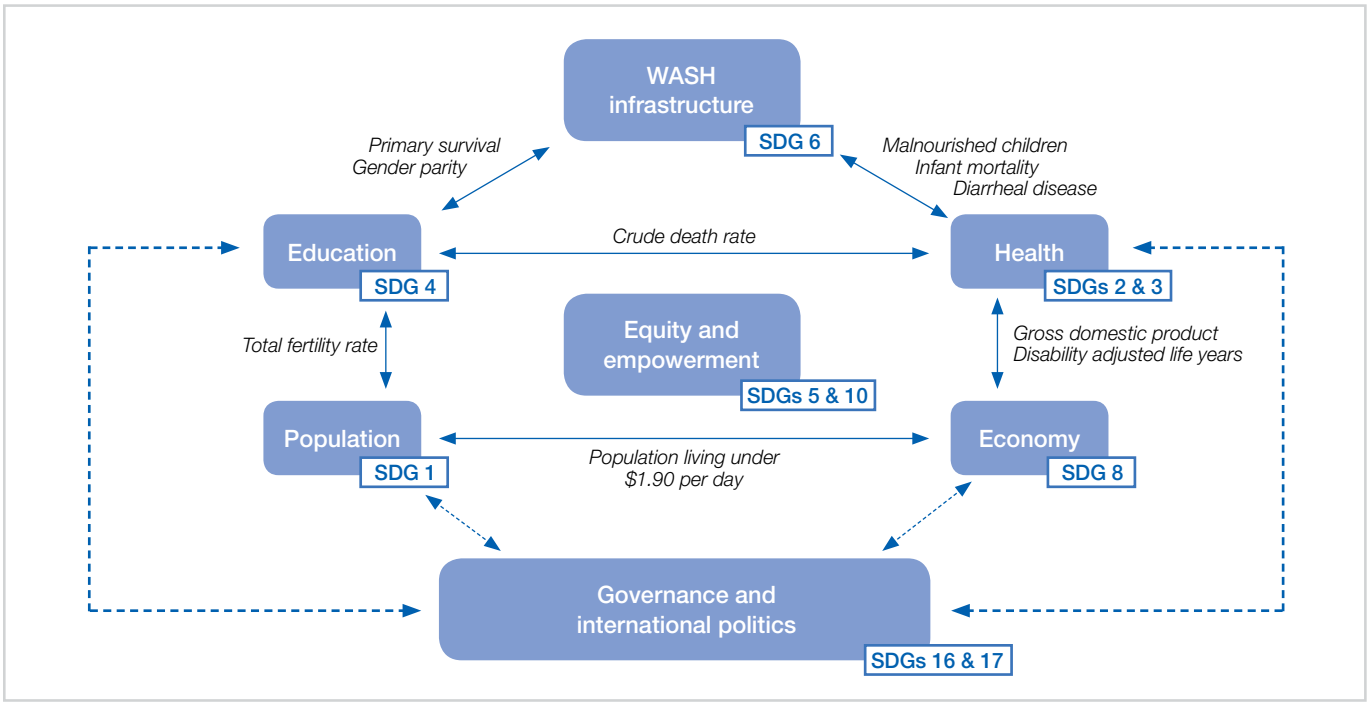
This paper focuses on the first two targets of SDG 6 for several reasons. First, WASH infrastructure is central to meeting people's most basic needs; in 2010 the UN declared access to clean water and sanitation a human right.[21] Second, water and sanitation are core infrastructure improvements that are critically important to advancing economic and social development, and which should be prioritised in the early stages of development.[22] And third, WASH targets support the broader Agenda for Sustainable Development via its direct and indirect impact on health, education, poverty, nutrition, equality and empowerment, and economic growth.[23]

The diagram in Figure 1 offers a simplified conceptualisation of the major relationships between SDG 6 and the larger 2030 Agenda for Sustainable Development. WASH infrastructure is directly (solid lines) related to SDG targets for health, education,

663 million

THE NUMBER OF PEOPLE WHO LACKED ACCESS TO IMPROVED DRINKING WATER GLOBALLY AT THE CLOSING OF THE MDG CYCLE

Figure 1: Flow chart of the relationships between SDG 6 and other Sustainable Development Goals



Source: Authors, adapted from International Council for Science (ICSU) and International Social Science Council (ISSC), Review of Targets for the Sustainable Development Goals: The Science Perspective, Paris: ICSU, 2015. & D Joshi, B Hughes, and T Sisk, Improving Governance for the Post-2015 Sustainable Development Goals: Scenario Forecasting the Next 50 Years, *World Development,* 70, 2015.

population and the economy. It also indirectly (dashed lines) affects equity and empowerment (particularly in the area of gender), governance, and capacity to engage with the international community. Each arrow points in both directions to reflect the reciprocal nature of the major realms of development.

In IFs, WASH infrastructure's strongest links to human development are through health. This is the area in which empirical research on the effects of WASH tends to be the most advanced. Child malnutrition, stunting, and infant mortality are all directly linked to WASH-related illnesses.[24] Diarrhoea is the most severe of these illnesses: UNICEF estimates that 1 600 children die each day from diarrhoea, and that more than half of these deaths are attributable to inadequate WASH infrastructure and access.[25]

> Child malnutrition, stunting, and infant mortality are all directly linked to WASH-related illnesses

WASH-related illness not only impacts the immediate quality of life of the affected individual, but also has spill-over effects on broader human and economic development outcomes. For instance, health indicators are some of the most robust correlates of macro-economic growth,[26] and chronic illness (e.g. water-borne parasites or bacterial infections) in childhood is correlated with lower individual human capital accumulation and lower adult income.[27] Moreover, individuals lose valuable income and time caring for sick family members. This is a burden that falls overwhelmingly on women, potentially having an impact on long-term gender equality outcomes.[28]

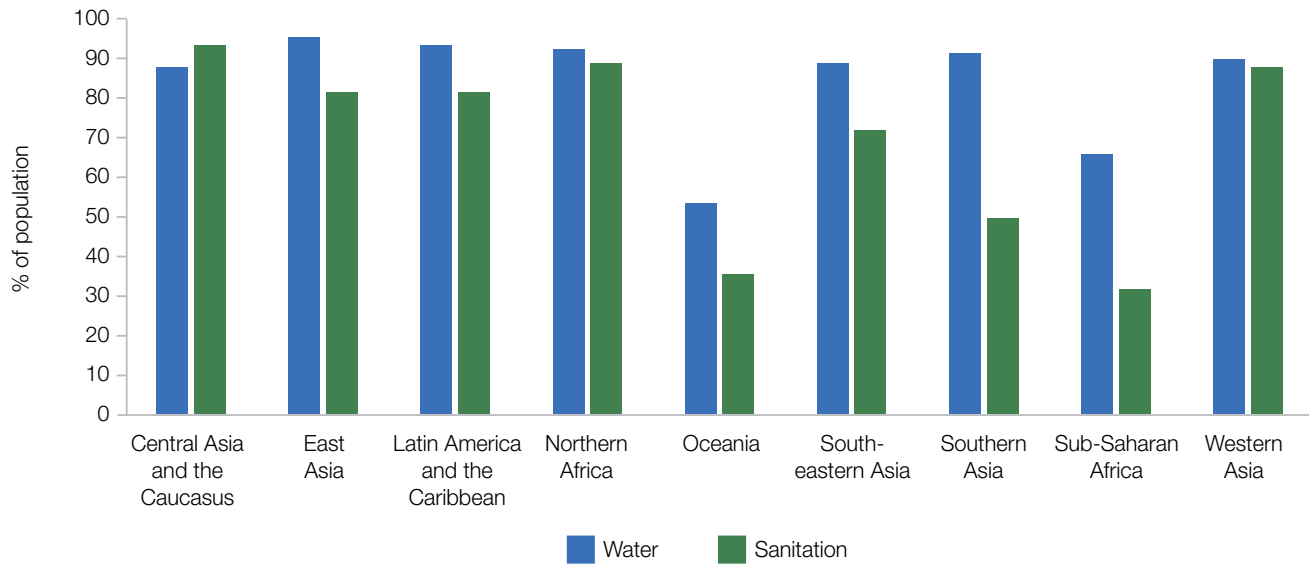
The goal of providing universal access to water and sanitation is thus critical to sustainable development. But questions remain: What will it take for African countries to achieve targets 6.1 and 6.2 by 2030? Are they realistic given available resources? And if not, what are the alternatives? The remainder of this paper seeks to shed some light on these questions.

Progress under the Millennium Development Goals

MDG 7's goal of halving the proportion of the population without water and sanitation access used JMP-calculated targets set at global and regional scales, and by level of development. The global target for water was 88% access to safe water among the world's population by 2015, and the target for access to basic sanitation was 77%. The world met the water target, but missed the sanitation target by nine percentage points.[29]

The JMP also set targets for nine regional groupings of developing countries.[30] By 2015, the end of the MDG period,

Figure 2: Per cent of population with access to water and sanitation in 2015 by JMP region



Source: WHO/UNICEF Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

there was significant variability in the level of access achieved between and within regions in both areas. Five developing regions missed the sanitation target and four missed the water target. Sub-Saharan Africa came up the shortest for sanitation at 32 percentage points shy of its relative goal of 62% access, and also missed its water target of 74% access. Oceania was the only region that underperformed sub-Saharan Africa, but only in terms of its proportion of water access. Northern Africa did manage to surpass its sanitation target of 86% access, but missed its water target of 94% access by one percentage point.[31]

Finally, the JMP set targets by level of development, measuring relative progress for developed, developing and least-developed countries. The latter group was unsuccessful in reaching either its water (75% access) or sanitation (60% access) targets, and performed especially poorly in the area of sanitation, reaching only 37% access. It included 49 countries, 35 of which were in Africa.[32] The failure of the least-developed countries to achieve this MDG, among others, reflects the integral link between WASH and countries' overall development.

Africa's WASH progress to 2015

The proportion of the global population with access to safe drinking water has increased significantly since the creation of the JMP in 1990, from 76% to 91% in 2015 (or 2.6 billion people in absolute terms), even with steady population growth. As noted above, however, Northern and sub-Saharan Africa were two of the five regions that missed MDG 7's mark for water access. The situation is most critical in sub-Saharan Africa, where, in 2015, 311 million people lacked a safe water source and the portion of people relying on untreated surface water for drinking was eight times higher than in any other region. Unusually large rural populations in the region contributes to low access in sub-Saharan Africa – globally 93% of those using untreated surface water live in rural areas.[33]

1 600

THE NUMBER OF CHILDREN UNICEF ESTIMATES DIE EACH DAY FROM DIARRHOEA

Using regional analysis alone hides intra-regional variation, however. Despite poor overall progress on water in sub-Saharan Africa, several countries did meet the target of halving the proportion of their population without access. Examples include Botswana, South Africa and Namibia, which provided 96%, 93%, and 91% of their populations with safe water respectively.[34]

Rates of access to sanitation are more variable in Africa than rates of water access. Northern Africa was able to meet the MDG target of halving the number of people without access to improved sanitation, while it did not meet the water target. In 2015, its sanitation coverage hovered just below 90%, with around 19 million people lacking access. Sub-Saharan Africa, meanwhile, made some of the least progress globally. In 2015, 682 million people in sub-Saharan Africa were living without improved sanitation – over 70% of the region's population. Moreover, the absolute number of people practicing open defecation actually increased in sub-Saharan Africa over the MDG period.[35]

> In 2015, 682 million people in sub-Saharan Africa were living without improved sanitation

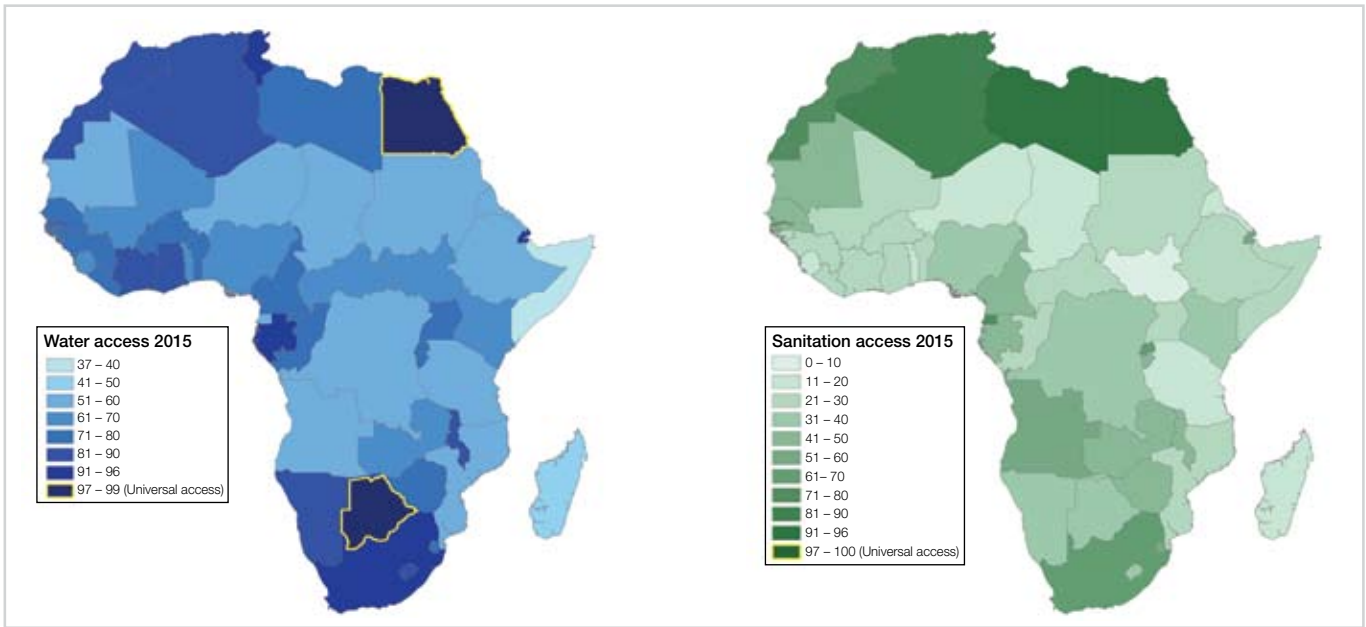
On a country level, Northern Africa's success as a region in meeting the sanitation target again hides the fact that not all countries were able to do so nationally. Libya and Algeria both missed their country-level benchmarks. Ethiopia, meanwhile, realised a gain in access to improved sanitation of 19 percentage points despite poor progress in sub-Saharan Africa as a region. It also achieved the largest decrease in the proportion of the population practicing open defecation globally, from 92% in 1990 to 29% in 2015.[36] The maps in Figure 3 show water and sanitation access levels across Africa in 2015.

African countries' variable, and often disappointing, progress toward MDG 7's WASH target demonstrates the formidable challenge that SDG targets 6.1 and 6.2 present to the continent. By the close of 2015, sub-Saharan Africa was home to countries with some of the world's lowest levels of access to both water and sanitation; for example, 49% safe water access in Angola and 6.7% improved sanitation access in South Sudan. These access rates point to a steep climb ahead to reach universal access.

Scenario analysis

This section presents three scenarios for WASH access in Africa from 2016 to 2030 that shed light on its potential prospects for achieving SDG targets 6.1 and 6.2. The first forecast is Africa's Current Path. The Current Path is sometimes referred to as a 'business as usual' forecast, and uses the IFs 'Base Case.' The Base Case is a collection of historical data and trends that represent a likely scenario of how the future will unfold. The Base Case assumes no major paradigm shifts, policy changes or 'black swans' (extremely low probability but high-impact events). Although the Base Case generally demonstrates continuity with historical patterns, it provides a structure that moves beyond a simple linear extrapolation of previous trends.

Figure 3: Maps of safe water and adequate access in Africa in 2015



Source: UNICEF/WHO Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

The Current Path is followed by the Universal Access and Balancing WASH scenarios. Each of these scenarios pushes Africa closer to a universal access threshold in both water and sanitation. The UN leaves it up to individual countries to determine their own definition of 'universal' access, and some have argued for the adoption of a 100% threshold.[37] This paper employs a more generous definition of universal access of 97%. This is the threshold that was used to define universal access for primary education in the MDGs,[38] and is one that takes into consideration the enormous challenge of providing access to the last 3–5%, or 'hard-to-reach' members of a population.[39]

Framing progress using country groups

To reflect the significant diversity that exists in WASH access levels across Africa, this paper uses country groups as a means to simplify and frame its analysis. Groups are based on the level of WASH access a country had achieved by the end of the MDG period (31 December 2015). There are three high-to low-access groups that each include countries within a given range of WASH access. Countries are assigned to a group based on a combined WASH access score that was calculated using the simple mean of their access rates for water and sanitation in 2015. While outliers exist, countries tend to reflect a similar level of access within each group for both indicators. Table 2 presents parameters and country examples for each group.[40]

Table 2: WASH country groups used for scenario analysis

WASH access country groups					
GROUP	Combined WASH Access Score 2015	Average Water Access 2015	Average Sanitation Access 2015	Number of Countries	Country Examples
GROUP A	76–100	93%	84%	10	Egypt, Botswana, South Africa, Tunisia
GROUP B	51–75	80%	35%	20	Senegal, Zimbabwe, Gabon, Ghana
GROUP C	50 or less	62%	24%	24	Mozambique, Eritrea, Angola, Nigeria

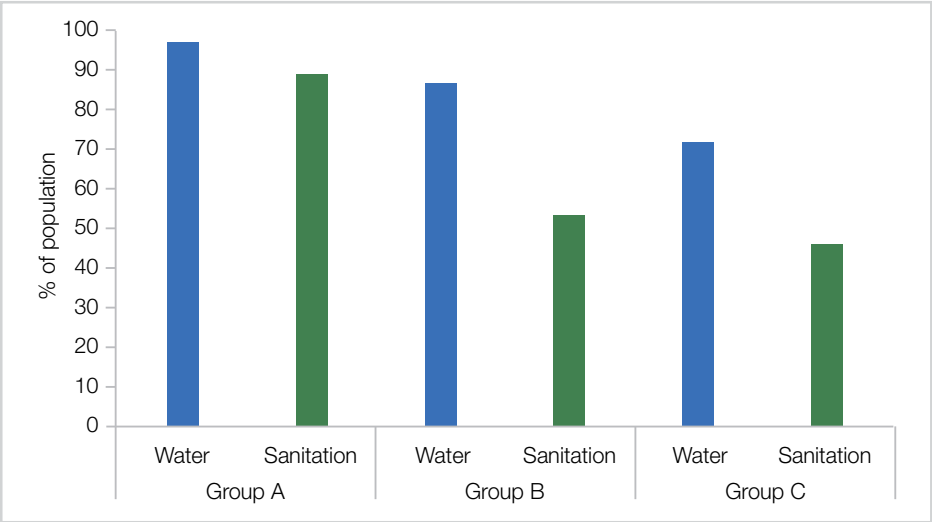
Source: Authors & UNICEF/WHO Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

AT THE END OF THE SDG PERIOD, SUB-SAHARAN AFRICA IS FORECAST TO REACH AN ACCESS RATE OF 75% FOR WATER

Scenario 1: Current Path

The Current Path forecasts improvement in WASH access in Africa during the SDG period. This is especially true for countries in Group C, for which water access increases by 11 percentage points on average and sanitation by 17 percentage points by 2030. Despite its more impressive growth rate, however, sanitation access remains far below that of water, with a marked disparity in access levels between groups. Group A manages 88% access to sanitation by 2030, while Group C and Group B only

Figure 4: Percentage of the population in each country group with access to safe water and adequate sanitation access in 2030, Current Path forecast

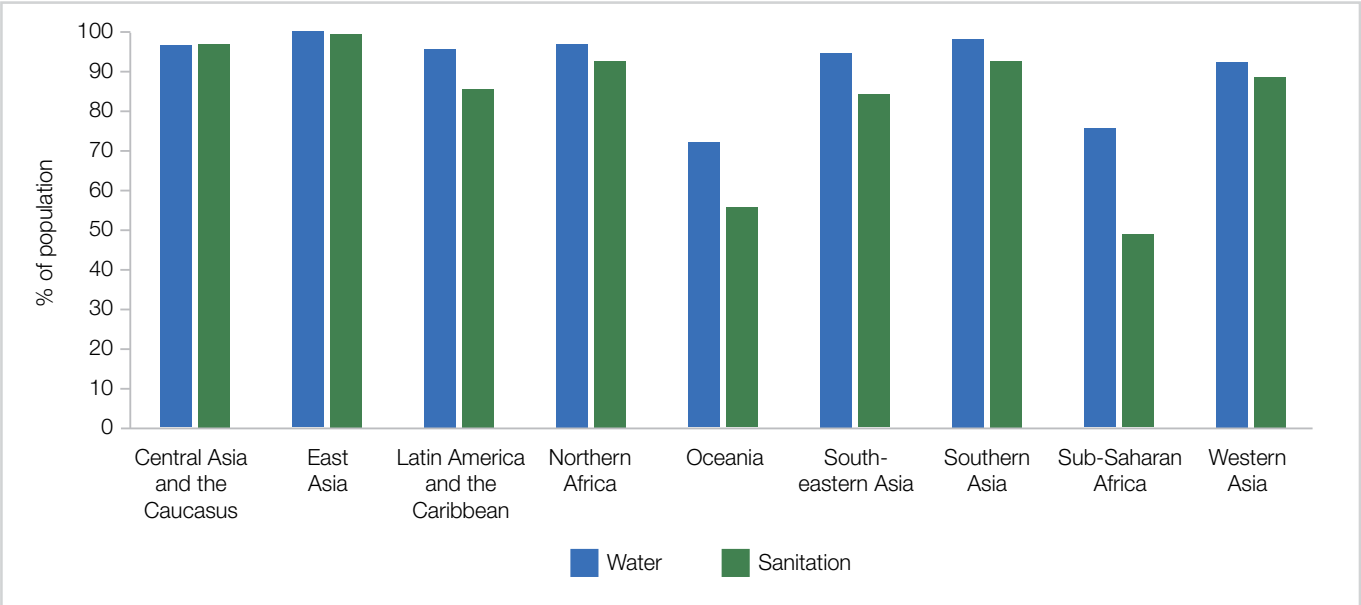


Source: International Futures 7.18.

reach 46% and 53% respectively.[41] Given Africa's higher baseline in water (compared to sanitation), all of the groups come nearer to achieving universal water access but still fall short, with Group A coming close at 96% access.

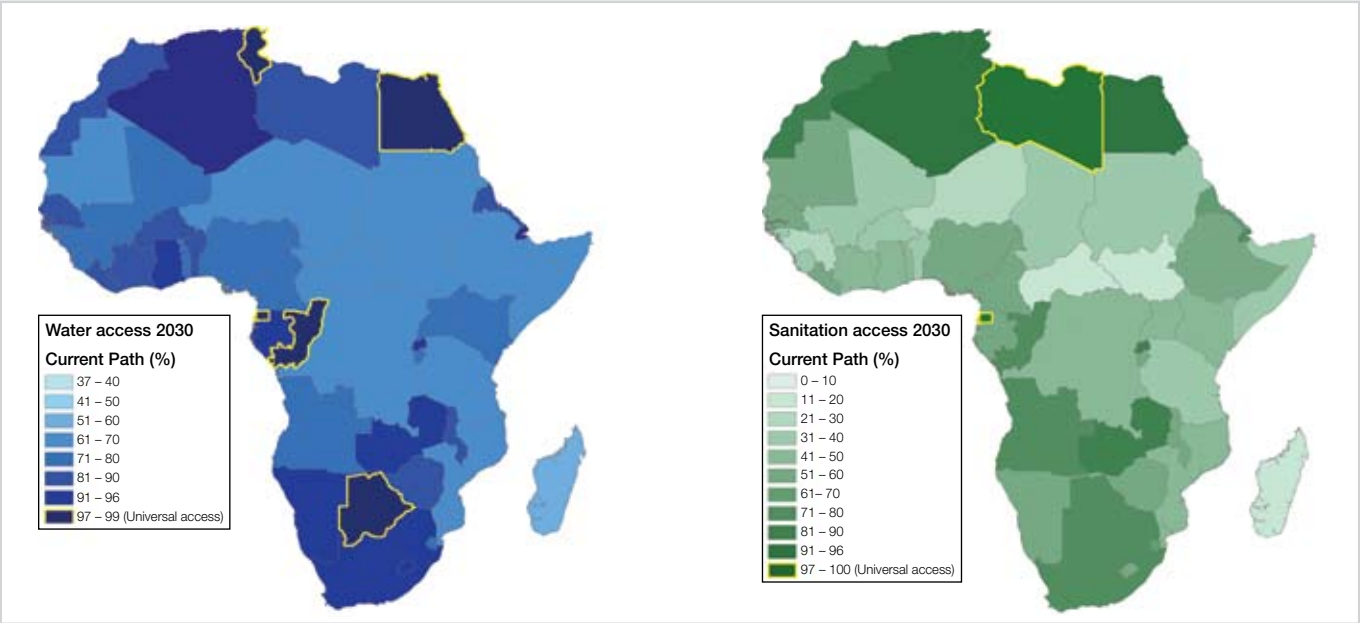
At the end of the SDG period, sub-Saharan Africa as a region is still expected to lag behind most other JMP-defined developing regions in terms of access to water and sanitation. Sub-Saharan Africa is forecast to reach an access rate for water of 75%, which is 3 percentage points above the lowest performer, Oceania, but still a full 23 percentage points below the 97% universal access threshold. It also continues to be the poorest-performing region for access to improved sanitation, at 49%. Northern Africa, on the other hand, performs relatively well, reaching 96% access to water and 92% access to sanitation.

Figure 5: Percentage of population with access to water and sanitation in 2030 by JMP region, Current Path forecast



Source: WHO/UNICEF Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

Figure 6: Maps of safe water and adequate sanitation access in 2030, Current Path forecast (small island states excluded)



Source: International Futures 7.18.

On the national level, only eight countries are currently forecast to reach the 97% access threshold for water. One of the eight countries that meets the water target is currently in Group C (Republic of the Congo), while the rest are in Group A (Egypt, Seychelles, Mauritius, Botswana and Tunisia) and Group B (São Tomé and Príncipe and Equatorial Guinea). Progress on sanitation is even less impressive, with only two Group A countries, Seychelles and Libya, and one Group B country, Equatorial Guinea, forecast to hit the target. On the Current Path, access to sanitation will still be as low as 17% (South Sudan) and water as low as 55% (Madagascar) in 2030.[42]

Low-income countries must make costly infrastructure investments while high-income countries have already constructed most core infrastructure

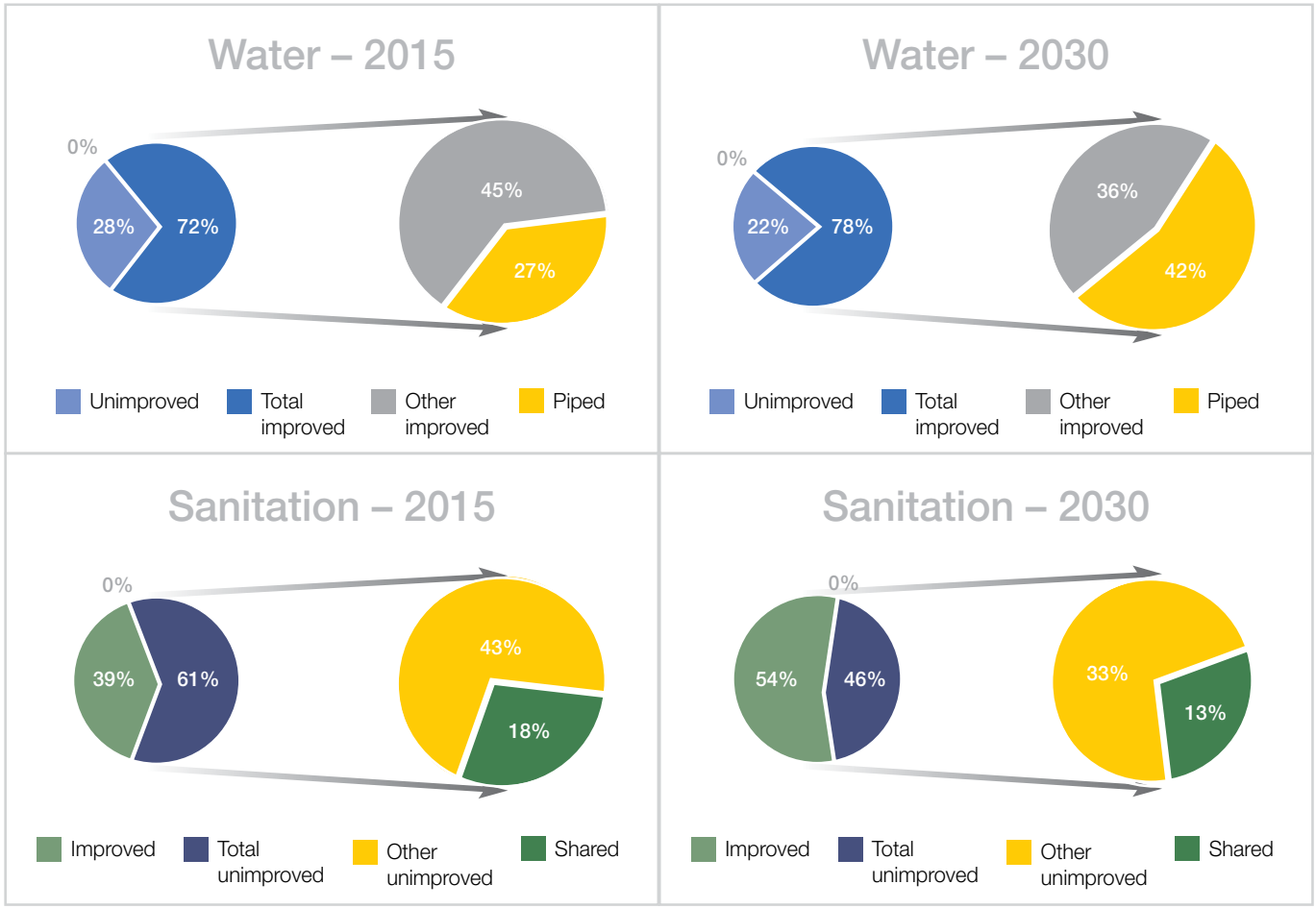
Rapid population growth is one of the major factors inhibiting the achievement of universal WASH access in Africa. Although the percentage of people in Africa without access to improved WASH infrastructure will decrease, the absolute number of people without access will actually increase from 2016 to 2030 on the Current Path due to high population growth across the continent (Africa's population grows from 1.17 billion in 2015 to around 1.65 billion in 2030). The Current Path shows that 365 million people in Africa will be without access to safe water in 2030, and 755 million without access to sanitation, compared to 337 million and 726 million respectively in 2015.

Figure 7 displays water and sanitation access in Africa in 2015 and 2030. Safe water access includes piped and other improved (e.g. protected wells), and adequate sanitation includes only improved sources (e.g. flush toilets), while unimproved sources include both shared facilities and other unimproved categories (e.g. open defecation).

755 million

THE NUMBER OF PEOPLE IN AFRICA WHO WILL BE WITHOUT ACCESS TO SANITATION IN 2030 IN THE CURRENT PATH SCENARIO

Figure 7: Population with access to improved and unimproved water and sanitation sources in Africa, 2015 and 2030



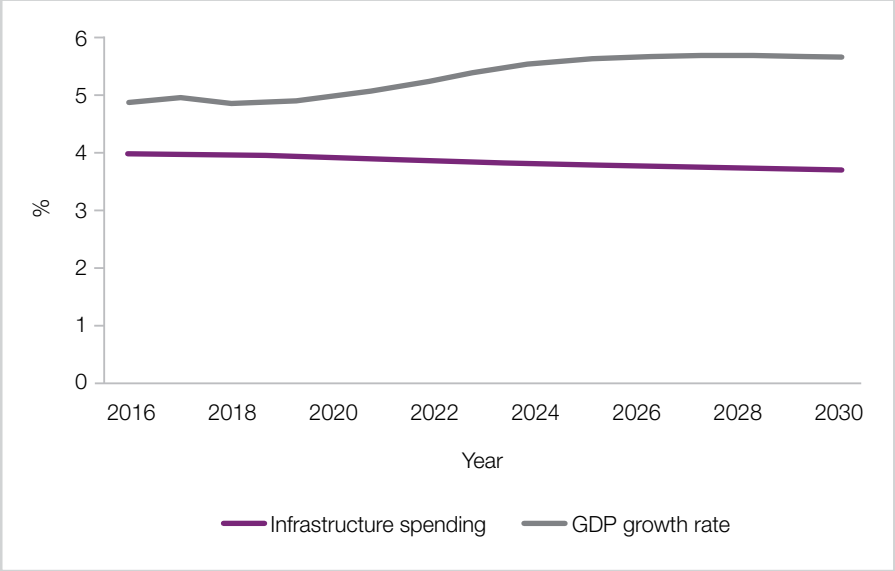
Source: International Futures 7.18 & UNICEF/WHO Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

The high cost of investing in infrastructure is also a significant challenge. IFs uses a per unit cost for infrastructure that takes into account estimates from several empirical sources. The cost of a piped household water connection in the model is US$653 in 2011 dollars, while other improved connections for water are much lower, at US$59. A household sanitation connection costs US$980 (over 70% of the average per capita gross domestic product [GDP] of both Group B and Group C at market exchange rates).[43] The model also uses a lower per unit cost for shared sanitation, but shared facilities are not currently considered improved by the JMP.

On the Current Path, cumulative spending on infrastructure across Africa is estimated to be US$2.2 trillion between 2016 and 2030, with the continent allocating an average of 3.8% of its GDP to that sector each year. Africa is also set to increase annual spending on infrastructure by more than 90% over the course of the SDGs, from US$104 billion in 2016 to US$199 billion in 2030. However, this significant increase in absolute spending is coupled with strong GDP growth in Africa, such that relative spending on infrastructure as a percentage of GDP actually declines to 2030. This is in line with global trends that see proportional investment in infrastructure decline as countries go up the income ladder (i.e. rich countries tend to spend less on infrastructure than poor countries and more on education and health) because low-income countries must make costly infrastructure investments while high-income countries have already constructed most core infrastructure and only have to spend on maintenance.

AFRICA IS SET TO INCREASE ANNUAL SPENDING ON INFRASTRUCTURE BY MORE THAN 90% OVER THE COURSE OF THE SDGS

Figure 8: Infrastructure spending as a percentage of GDP and GDP growth rate for Africa from 2016–2030, Current Path forecast (using a five-year moving average)



Source: International Futures 7.18.

The Current Path makes it clear that, without additional intervention, few countries in Africa will achieve targets 6.1 and 6.2 of the SDGs. In response to this pessimistic forecast, the sections below present two alternative scenarios that reflect more aggressive approaches to improving WASH access to 2030 than what is forecast in the Current Path. These scenarios highlight the costs and benefits of Africa advancing targets 6.1 and 6.2 more rapidly than is currently expected.

Scenario 2: Universal Access

As the previous section demonstrated, Africa is not currently on track to meet SDG 6. The Universal Access scenario simulates an aggressive push toward 100% access to evaluate the costs and benefits of such an intervention. In this scenario, Africa as a continent is able to achieve universal water access; however, even with the most optimistic intervention it falls one percentage point short of the 97% threshold in access to improved sanitation.

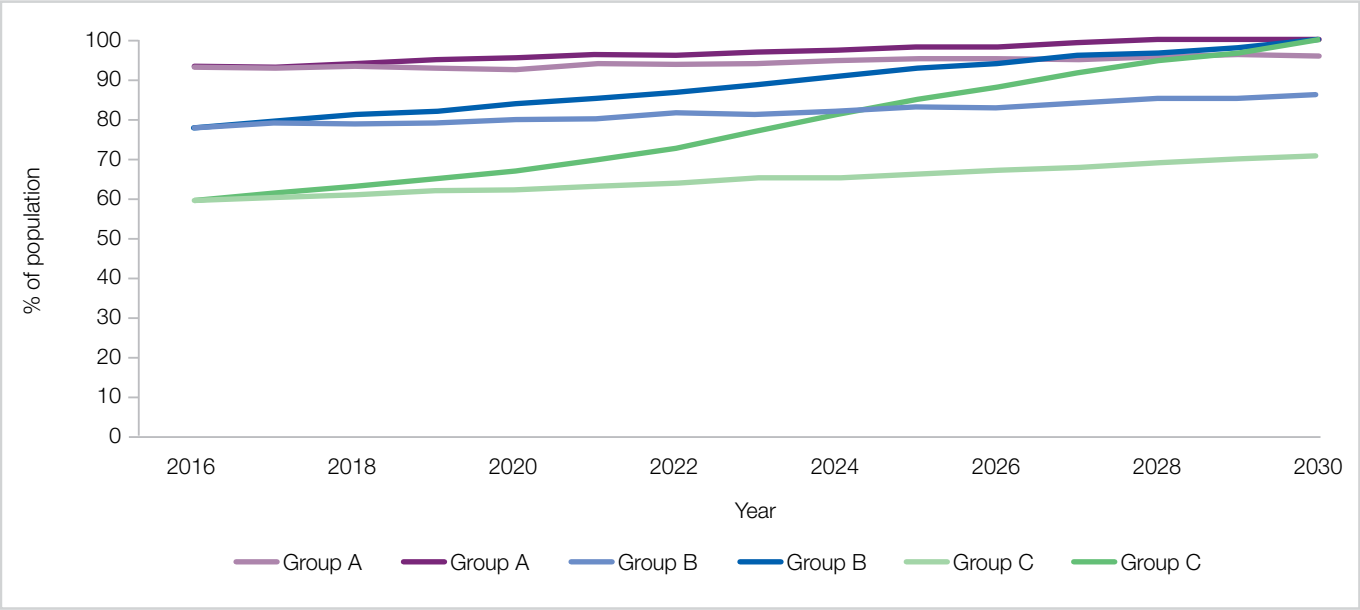
>3X

THE ANNUAL GROWTH RATE IN WATER ACCESS REQUIRED IN THE UNIVERSAL ACCESS SCENARIO COMPARED TO AFRICA'S CURRENT PATH

> The Current Path makes it clear that, without additional intervention, few countries in Africa will achieve universal WASH access

The Universal Access scenario requires Africa's average annual growth rate in water access to be four times the rate that is expected on the Current Path – 2.0 percentage points annually compared to 0.5 percentage points annually. Between 2000 and 2015 the growth rate in water access was around 0.7 percentage points annually in Africa, so it also represents a notable increase over the growth in access that Africa sustained under the MDGs. Group C's growth rate rises the highest over the Current Path in this scenario, from 0.7 percentage points to 2.7 percentage points annually.

Figure 9: Percentage of the population with access to safe water from 2016–2030, Current Path and Universal Access scenarios



Source: International Futures 7.18.

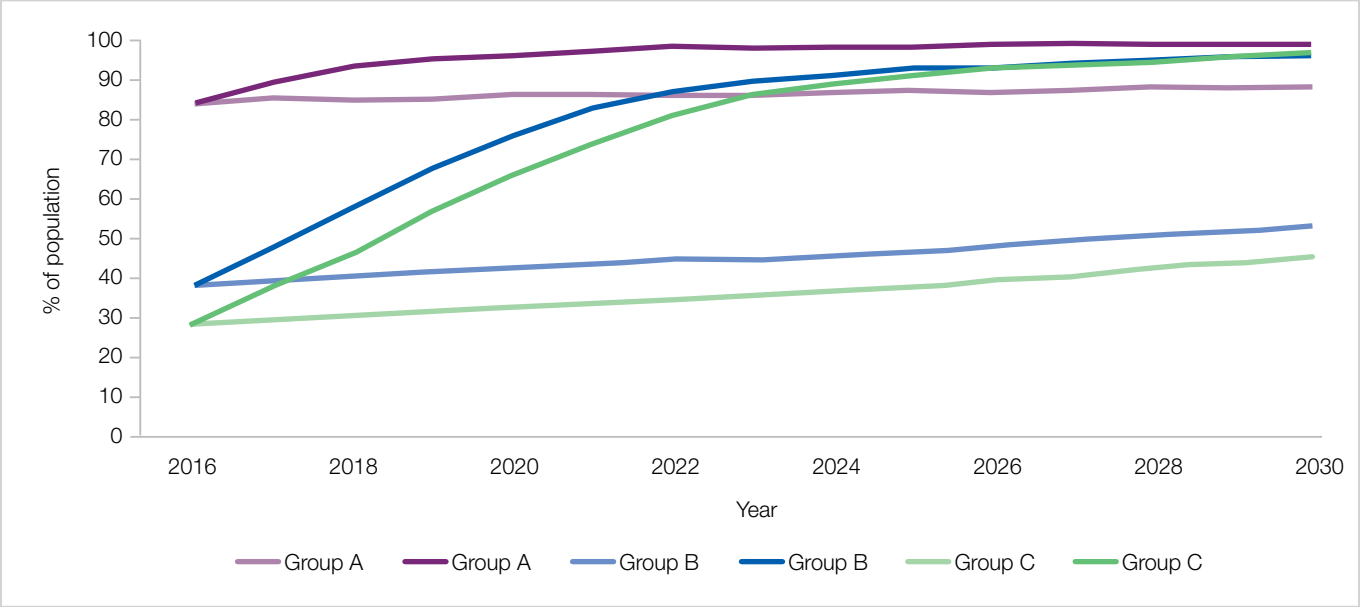
No country in the world achieved an annual growth rate in water access of 2.7 percentage points or greater under the MDGs. Cambodia saw the fastest growth, at 2.3 percentage points annually. Mali had the highest rate in Africa, at 2.0 percentage points annually. Each of these countries was also starting from a baseline that was lower than Group C's average. For instance, Mali started with 46.6% water access in 2000 and increased it to 77%, and Cambodia started from a 41.6% access baseline.[44] Given that water access is starting at close to 60% for most low-access countries, and that Cambodia and Mali were outliers under the MDGs, achieving the necessary level of growth in water is certain to be a formidable challenge for most countries.

The required increase in average annual growth in sanitation access in the Universal Access scenario is likewise substantial. Africa will have to more than quadruple its annual growth rate in sanitation access from 0.8 percentage points on the Current Path to 3.7 percentage points in the Universal Access scenario. This pattern is echoed in the groups, with Group C needing an annual growth rate of 4.5 percentage points, as opposed to 1.1 percentage points on the Current Path. Historically, Laos achieved the highest rate of annual growth in sanitation access under the MDGs, at 2.9 percentage points, while Ethiopia was the top performer in Africa at 1.3 percentage points annually, less than half the growth rate required by Group C in this scenario.[45] Thus, meeting target 6.2 will require an unprecedented rate of access improvement in many countries.

Reaching and maintaining the rapid annual growth rate in WASH access that is required by the Universal Access scenario calls for a massive investment in infrastructure over the next 15 years. IFs estimates that Africa will require an additional US$122 billion in infrastructure spending above the Current Path by 2030, or an average of about US$8 billion annually over the next 15 years. Group B is the biggest relative spender on infrastructure as a per cent of GDP in the Universal Access

MALI STARTED WITH 46.6% WATER ACCESS IN 2000 AND INCREASED IT TO 77%

Figure 10: Percentage of the population with access to adequate sanitation from 2016–2030, Current Path and Universal Access scenarios



Source: International Futures 7.18.

scenario. Its spending on infrastructure peaks at 5.7% around 2018, or 0.5% above the Current Path. Group A, meanwhile requires the lowest relative annual spending on infrastructure, at less than 4% of GDP.

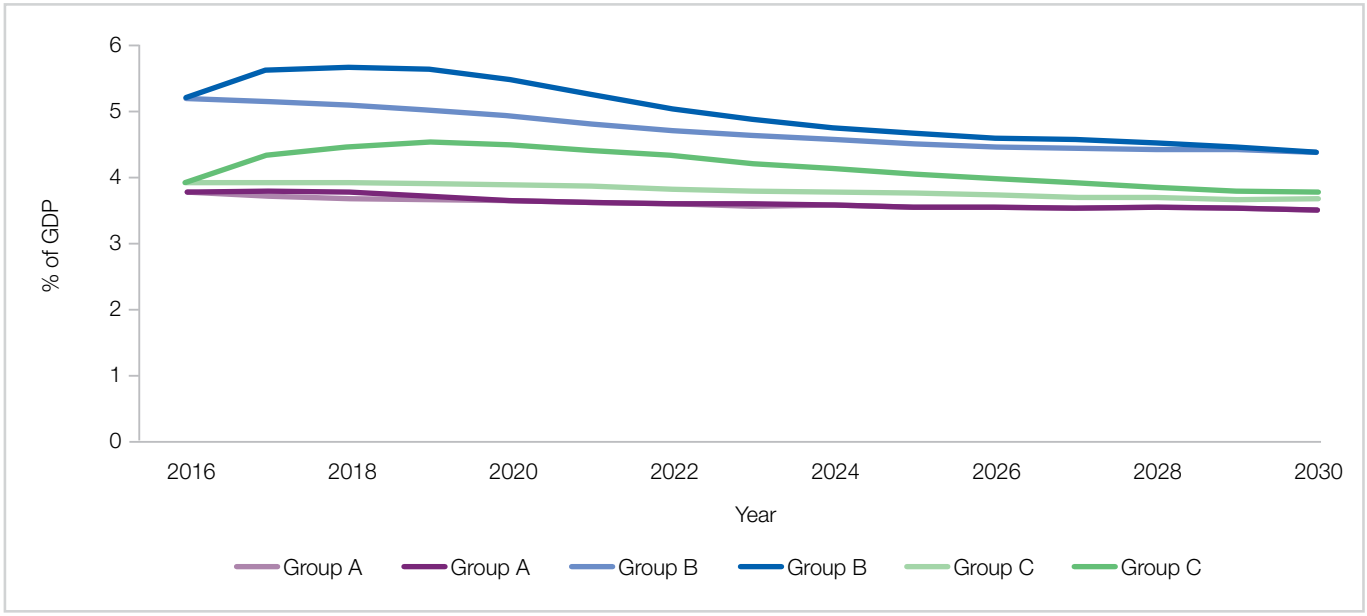
Finally, Group C spends relatively less on infrastructure as a per cent of GDP than Group B, but accounts for the majority of the additional spending in the scenario in absolute terms due to its much larger population. Group C's population in 2015 was around 729 million people, whereas Group A's was 238 million and Group B's 207 million. Group C's population is moreover expected to grow by 344 million people in all three scenarios by 2030, while the other two remain under 300 million people. As such, Group C captures around 76.5% (US$93 billion) of the additional spending on infrastructure that is required to reach universal WASH access in Africa in the Universal Access scenario. Group B and Group A, meanwhile, account for 16% (US$20 billion) and 7.5% (US$9 billion) respectively.

> Maintaining the rapid annual growth rate in WASH access required by the Universal Access scenario calls for a massive investment in infrastructure over the next 15 years

HEAVY INVESTMENT IN WATER AND SANITATION HAS LARGE PAYOFFS IN TERMS OF INCREASED ECONOMIC PRODUCTIVITY

Although the Universal Access scenario has substantial costs, heavy investment in water and sanitation also has large payoffs in terms of increased economic productivity.[46] In the Universal Access scenario, a cumulative total of US$356 billion is added to Group C's GDP alone from 2016 to 2030, while US$83 billion is added to Group B's GDP, and US$87 billion to Group A's. This boost in economic productivity (totalling US$526 billion) is over four times the additional infrastructure investment required for this scenario. Africa's GDP increase in the Universal Access scenario in the

Figure 11: Government spending on infrastructure as a percentage of GDP, Current Path and Universal Access scenarios



Source: International Futures 7.18.

year 2030 alone is greater than the cost of the intervention, at US$127 billion over the Current Path.

Another lens through which to view the benefits of a major push for universal access to improved water and sanitation is its impact on human development. Here again, Group C sees the most significant deviations from the Current Path. Figure 12 presents the improvements between the three groupings in GDP per capita at purchasing power parity (PPP), annual deaths from diarrhoeal disease per million people, percentage of children that are malnourished,[47] and infant mortality rate (the number of deaths of children under one years old per 1 000 live births).

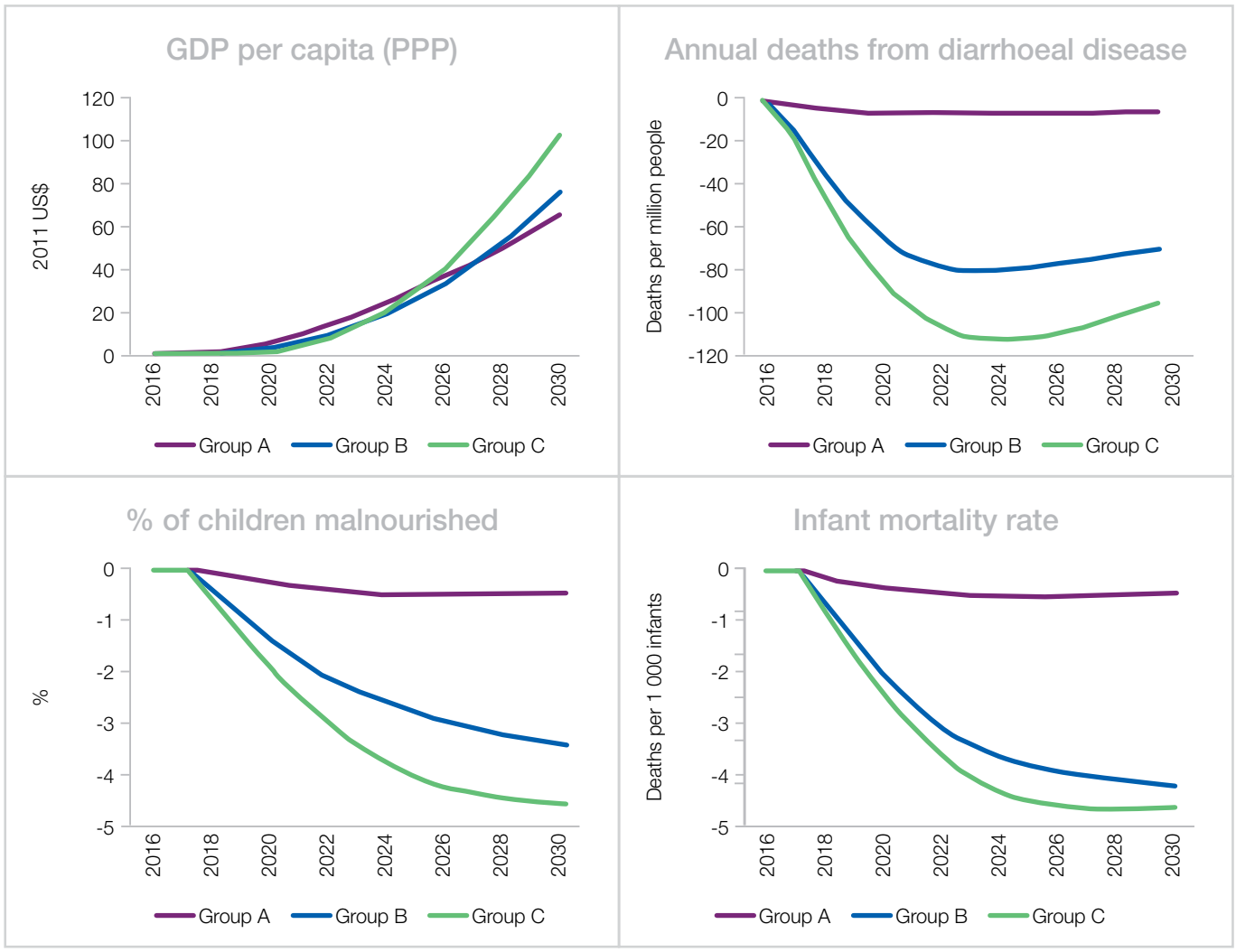
> Although the Universal Access scenario has substantial costs, heavy investment in water and sanitation also has large payoffs in terms of increased economic productivity

In 2030, Group C countries will enjoy a US$100 improvement in GDP per capita, and be home to much healthier populations, with nearly five fewer infants dying annually per 1 000 live births; 5 percentage points fewer malnourished children; and just under 100 fewer deaths per million from diarrhoeal disease. Group B also sees significant human development improvements, although its per capita GDP increase is less impressive. Group A experiences relatively little improvement to development in this scenario, indicating that investing in WASH has far more impact where access is especially low.

In Universal Access, the majority of the financial push needed to expand WASH infrastructure in Africa occurs within the first 10 years. Total spending on WASH infrastructure in Africa peaks in 2018 and 2019, when infrastructure spending as a per cent of total GDP goes from 4% on the Current Path to 4.3% in this scenario,

A MAJOR PUSH FOR UNIVERSAL ACCESS TO IMPROVED WATER AND SANITATION WILL HAVE A POSITIVE IMPACT ON HUMAN DEVELOPMENT

Figure 12: Difference in four key human development indicators by group, Universal Access scenario minus Current Path scenario



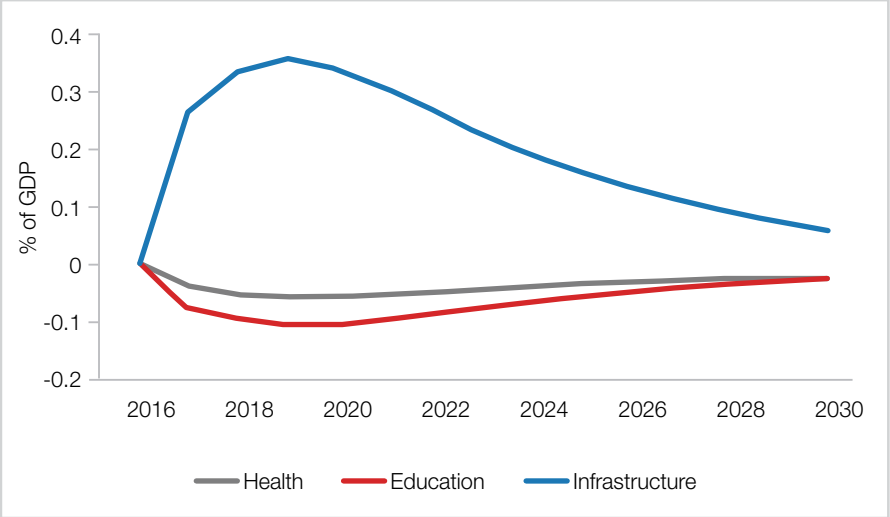
Source: International Futures 7.18.

and steadily declines thereafter. This reflects the fact that once infrastructure is constructed, the cost of maintaining WASH services (and the human development gains made from increased access) is substantially lower than the initial investment.[48]

Despite the eventual decrease in cost and growth in GDP, however, achieving universal, or at least near-universal, WASH access by 2030 may require a diversion in spending away from other development priorities. Some of the spending on WASH in this scenario is sourced from spending reductions on other infrastructure investments – non-core infrastructure such as railroads, ports, and airports, for instance, loses around US$16.5 billion of funding between 2016 and 2030 in this scenario. But if WASH access is to be pursued aggressively by these countries, the rest will have to come from other sectors of the economy or external funding sources.

Should Africa fund WASH domestically, IFs forecasts that much of the additional money required by the Universal Access scenario is likely to come from health and education budgets.[49] These are two other important spending priorities under the SDG framework, and a loss of resources will inevitably affect progress in those areas. Figure 13 portrays the trade-offs between infrastructure, health, and education spending in

Figure 13: Difference in government spending to health, education, and infrastructure as a percentage of GDP for Africa, Universal Access scenario minus Current Path scenario



Source: International Futures 7.18.

terms of the difference in the percentage of GDP that will be spent on each sector in the Universal Access scenario.

Therefore, one important conclusion of this research is that the noteworthy improvements in human development and GDP seen in the Universal Access scenario have spending trade-offs that could hinder long term human capital formation. Seeing a macro-level return on investment in education, for instance, takes generations, and it takes just as long to recognise the full consequences of significantly reducing education funding.[50] By 2030 the Universal Access scenario already begins to reduce the average years of education (by .03 years for Africans over 25 years old) and upper secondary graduation rates (by 0.5% for Africa) in each of the three country groups.

> Achieving universal, or near-universal, WASH access by 2030 may require a diversion in spending away from other development priorities

In sum, the Universal Access scenario indicates that countries at lower levels of access will see significant benefits from an aggressive push on WASH infrastructure, but they may also face stark trade-offs in other areas of development as a result of pursuing the goal of universal access. Up to this point, this paper has assumed that countries will rely largely on domestic resources as they seek to achieve SDG 6. In reality, though, funding may also be available from external sources to help offset the spending trade-offs forecast above.

Alternative resources for sustainable development

The figures presented in all three of this paper's scenarios assume that overseas development assistance (ODA) to Africa will increase by roughly one-third from its current level, from US$62 billion in 2015 to US$85 billion in 2030. This level of foreign aid is included in the forecasts of government spending, but the figures could change.

A MACRO-LEVEL RETURN ON INVESTMENT IN EDUCATION TAKES GENERATIONS

WASH appears to be a higher priority on the development agenda today than it was at the initiation of the MDGs, as demonstrated in the growing percentage of donor funds allocated towards the sector in recent years. This change could serve as a catalyst to accelerate WASH access growth in Africa.

A recent report from the WHO and UN-Water estimates that WASH receives the fourth-largest proportion of ODA in Africa, representing 7.6% of total aid to the continent, or US$4.4 billion in 2013.[51] This is up from 4% of total ODA in 2000 and a low of 3.1% in 2002. If this level of support for WASH infrastructure is maintained, Africa can expect about US$85 billion in assistance for WASH from 2016 to 2030, but again, this is already included in the forecasts.

The SDGs also include a goal for increased assistance from the international community. Goal 17 of the SDGs calls for, among other things, the mobilisation of, 'additional financial resources for developing countries from multiple sources.'[52] If this goal is successfully implemented it will help developing countries achieve a range of SDG targets, including universal access to water and sanitation.

> Countries may want to consider alternative approaches to pursuing Sustainable Development Goal targets

Supposing the amount of aid destined for WASH increases at a level that is commensurate with the 2002–2012 change, the total percentage of foreign aid targeted for water and sanitation infrastructure will climb to 11.2% by 2030. In nominal terms, this amounts to a cumulative increase of US$26 billion above the US$85 billion that is forecast to go to WASH in the scenarios presented here. ODA for WASH would have to be increased overnight to more than double its current level, to reach the level of investment required for Africa to meet the universal targets.

Development assistance was a valuable tool for addressing the MDGs, but it is unlikely to be sufficient to achieve the full list of 169 individual targets outlined in the SDGs. It is also generally less efficient than relying on domestic resources. In recognition of this reality, the UN organised the Addis Ababa Action Agenda, which outlined several additional mechanisms for developing countries to enhance their financial capacity to meet the SDGs. Along with ODA, the Addis Ababa Action Agenda identified international trade; direct investment from the private sector; responsibly managed debt obligations and refinancing; capacity building through technology transfer; improved global economic governance; and a more efficient mobilisation of domestic resources as potential financial tools for achieving the SDGs.[53]

The resource requirement for meeting targets 6.1 and 6.2 forecast in the Universal Access scenario suggests that countries will need to employ some if not all of the aforementioned mechanisms to meet the ambitious goals set out in the post-2015 agenda. But even these might not be sufficient. Therefore, countries may want to consider alternative approaches to pursuing SDG targets such as 6.1 and 6.2. One available alternative is for countries to set adjusted individual targets, taking into consideration their starting point as well as the impacts each target will have on other national development objectives. The Balancing WASH scenario presented below is intended to represent such an approach, and demonstrates that even without achieving targets 6.1 and 6.2, countries can enjoy many of the underlying benefits to human development the targets are meant to achieve for a much lower cost.

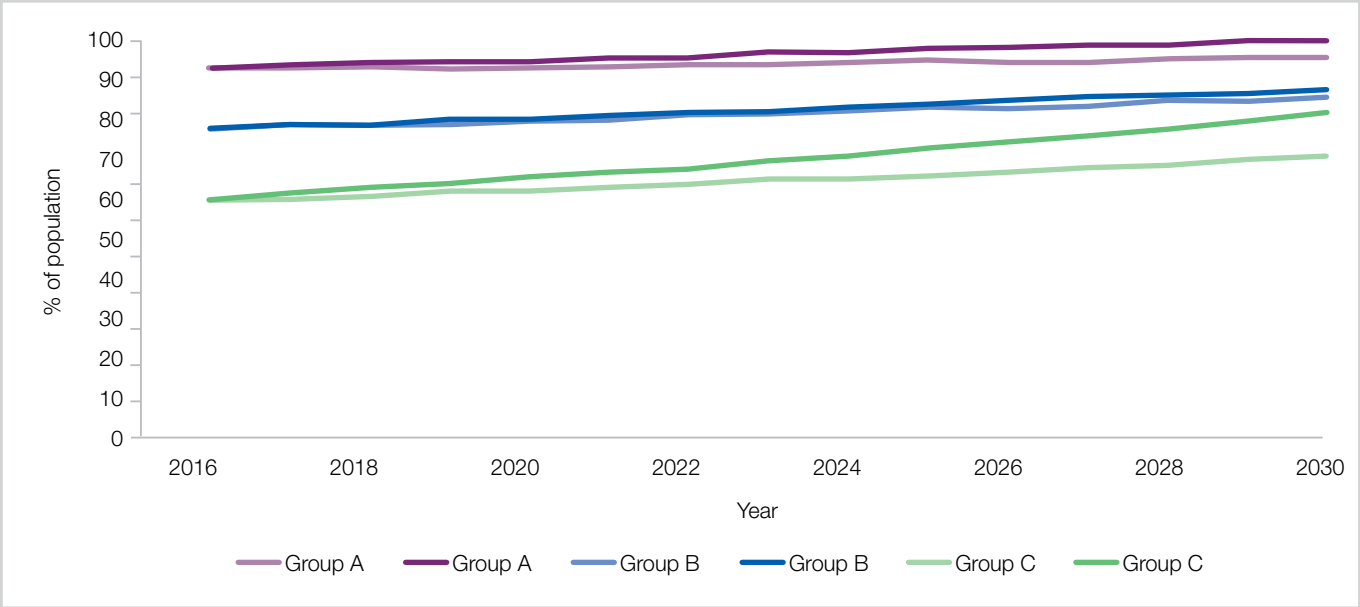
Scenario 3: Balancing WASH

'Balancing WASH' is intended to model an approach to pursuing the SDGs that is less capital-intensive. It is a scenario in which countries prioritise spending on targets that have the largest impact on their respective development needs. In this scenario, most countries do not pursue universal access at all costs, but instead weigh the decision to invest in WASH infrastructure against other development priorities set out by the post-2015 agenda.

The Balancing WASH scenario thus takes a more moderate approach than the Universal Access scenario to accelerating Africa's progress toward meeting SDG 6's first two targets. This scenario uses a relative targeting method that takes countries' 2015 baselines and current levels of development into account.[54] For SDG 6, this means that fewer countries achieve universal access, in part because targets 6.1 and 6.2 are a lower priority for countries that already have relatively high baselines, and in part because the level of available resources is well below that required to meet the goal. However, low-access countries still make good progress toward universal access, given WASH's importance to their development.

In the Balancing WASH scenario, the WASH-access increase over the Current Path is most prominent in Group C, where there is the greatest need for improvement and where human development outcomes are the most significant. In this scenario, access to safe water sources improves by roughly 11 percentage points over the Current Path in Group C (to 82%), three percentage points in Group B (to 88%) and four percentage points in Group A (to 100%) by 2030. This level of growth in water access in Africa is a little over half the rate in the Universal Access scenario. In Universal Access, water had

Figure 14: Safe water access from 2016–2030, Current Path and Balancing WASH scenarios



Source: International Futures 7.18.

to grow by 2.0 percentage points annually at the continental level, and for Balancing WASH it is 1.1 percentage points (compared to 0.5 percentage points on the Current Path). Group C meanwhile doubles rather than nearly quadrupling, from 0.7 percentage points in the Current Path to 1.5 percentage points in Balancing WASH (compared to 2.7 percentage points in Universal Access).

Balancing WASH also results in the growth of the per cent of people with access to improved sanitation facilities in all three country groups. The change is again most significant for Group C, which goes from having an average access level of 24% in 2015 to 61% in 2030. Group B countries move more slowly, from 35% to 61% and Group A countries from 84% to 92% over the same time horizon. In terms of annual percentage growth, Africa increases sanitation access at a rate of 1.6 percentage points in this scenario (compared to 3.7 percentage points in Universal Access), or double the 0.8 rate on the Current Path, and Group C grows at a rate of 2.1 percentage points (compared to 4.5 percentage points in Universal Access). In this scenario both Africa and its fastest-growing group sustain growth rates in WASH access which are on par with those achieved by the highest-performing countries under the MDGs, but still well above Africa's average in the MDG period.

Development assistance was a valuable tool for addressing the MDGs, but it is unlikely to be sufficient to achieve the full list of targets in the SDGs

As shown in figures 14 and 15, groups B and C fall short of the universal access target for water in this scenario, and none of the groups achieve universal sanitation access (as defined by the 97% threshold). This reflects slower progress toward universal access on a country level in the Balancing WASH scenario as compared to the Universal Access scenario. The maps in Figure 16 show water and sanitation

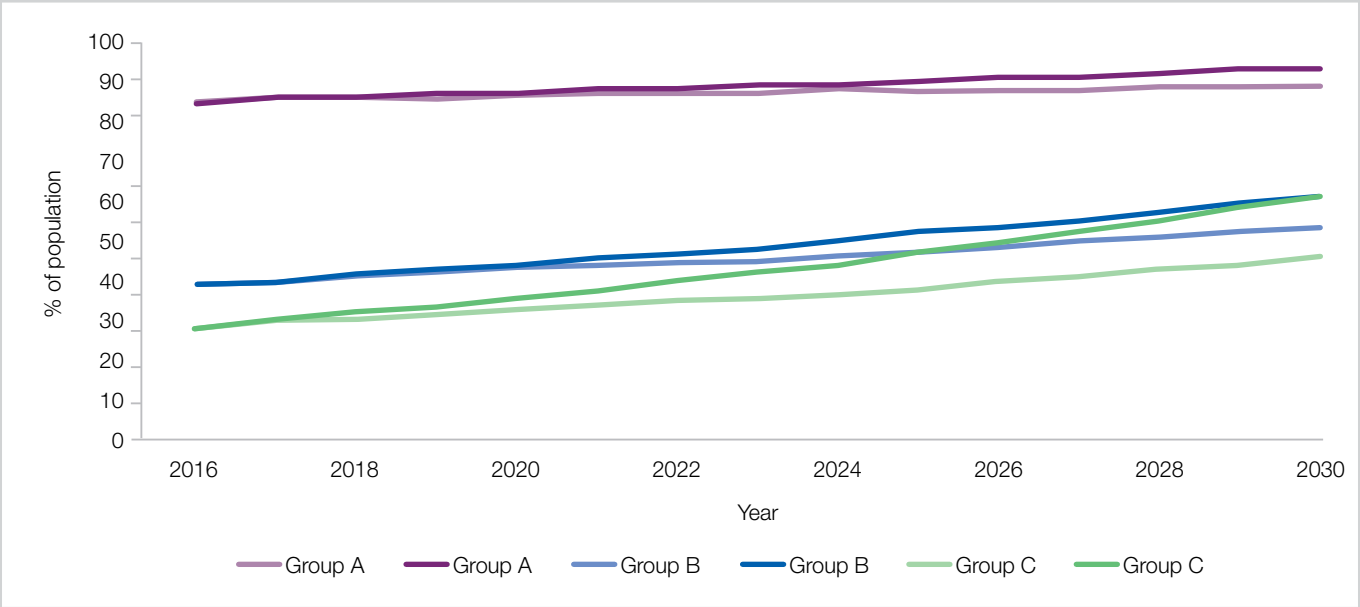
±US$85 billion

THE ASSISTANCE AFRICA CAN EXPECT FOR WASH FROM

2016 to 2030

IF CURRENT LEVELS OF SUPPORT ARE MAINTAINED

Figure 15: Safe water access from 2016–2030, Current Path and Balancing WASH scenarios



Source: International Futures 7.18.

access by country after both interventions. Countries that achieve Universal Access are outlined in yellow, and tend to be concentrated in the northern and southern parts of the continent. These also tend to be countries in Group B and Group A, although most Group C countries also achieve universal access to water in the Universal Access scenario.

While fewer countries meet targets 6.1 and 6.2 in Balancing WASH, the cost of this intervention is only 30% that of the Universal Access scenario, and it still yields significant improvements in economic and human development indicators. In it, infrastructure spending above the Current Path totals US$36 billion over 15 years. Group C absorbs an even larger portion of the additional expenditure at US$29 billion (80%) than it did in Universal Access (76.5%). Group B meanwhile receives only US$3.5 billion more (10%, compared to 16% in Universal Access) and Group A US$3.5 billion (10%, compared to 7.5% in Universal Access).

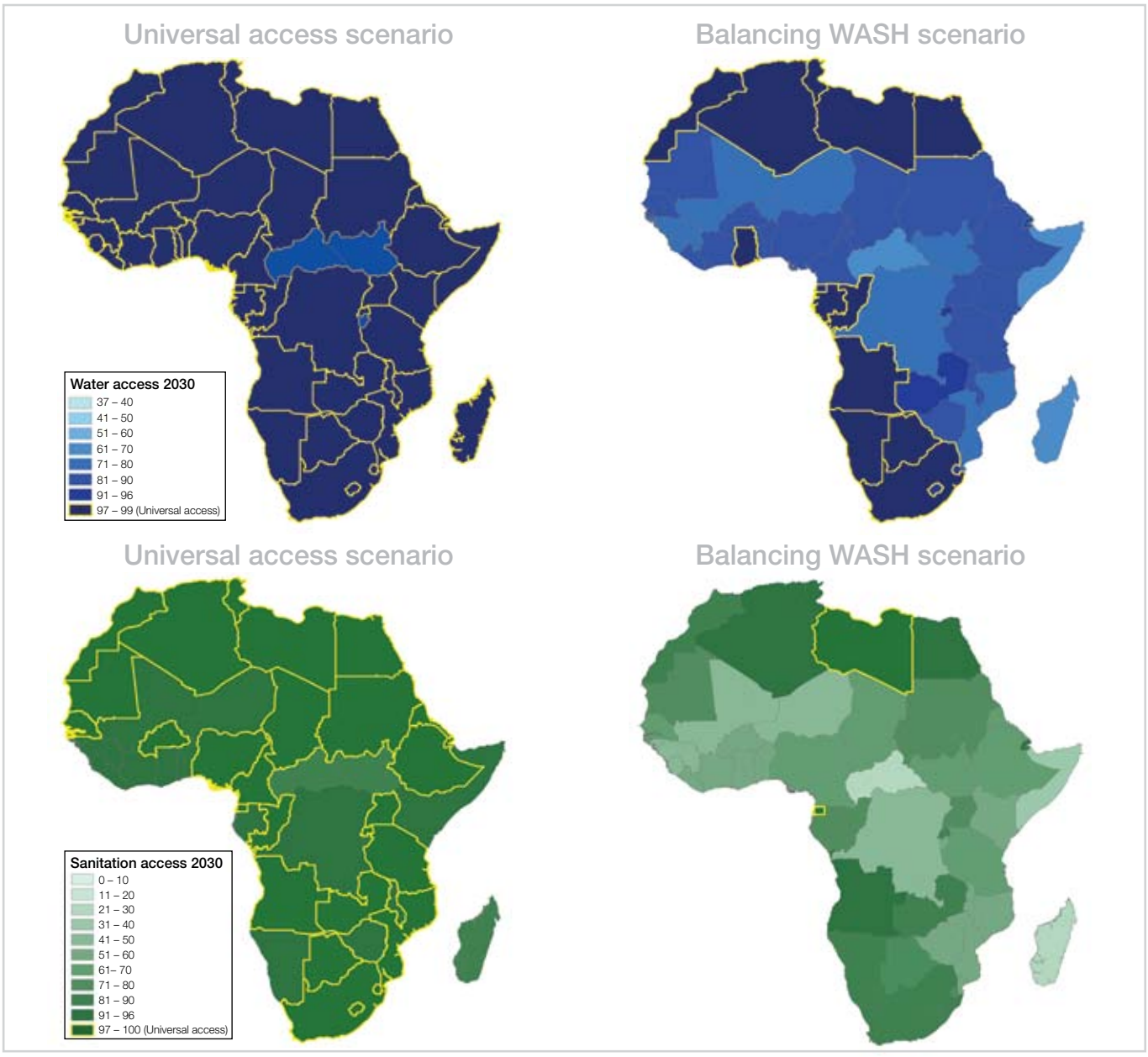
Nevertheless, the economic gains in the Balancing WASH scenario in terms of cumulative GDP more than pay for the US$36 billion investment needed, although they are less impressive than those in the Universal Access scenario. Group A adds US$99 billion, Group B adds US$15 billion, and Group C adds US$25 billion (totalling US$139 billion) from 2016 to 2030. The spending increase on infrastructure also rises more gradually above the Current Path in this scenario, reflecting short-term spending trade-offs that are less severe than in Universal Access. Figure 17 makes this clear: the diversion in government spending as a percentage of GDP from health and education to infrastructure is far less noticeable than that in Figure 13.

Finally, for Group C countries the Balancing WASH scenario results in human development outcomes for the four variables presented above that are around 50% those of the Universal Access scenario on average. The percentage of malnourished children and the infant mortality rate both decrease by over half the amount that they do in Universal Access. In Balancing WASH, the rate of malnourished children is 2.8 percentage points lower than on the Current Path, compared to 4.6 percentage points in the Universal Access scenario, and the infant mortality rate decreases by 2.6 deaths per 1 000 infants, compared to 4.7 deaths in Universal Access. GDP per capita and deaths from diarrhoeal disease are less affected, however. And the human development gains in Groups A and B are fairly modest.

> The economic gains in the Balancing WASH scenario more than pay for the US$36 billion investment needed

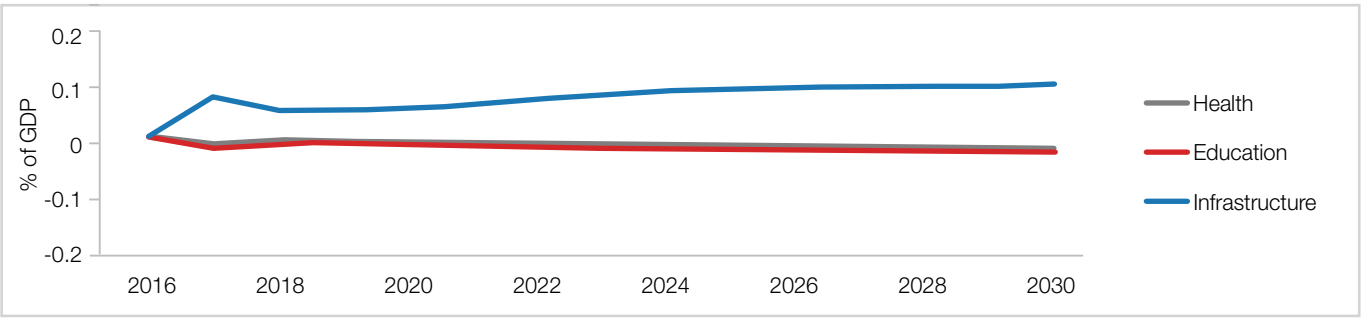
The Balancing WASH scenario represents a path to pursuing targets 6.1 and 6.2 of the SDGs that may be more realistic considering historical access growth rates and given the resources currently available to African countries. This scenario still involves spending trade-offs, but they are more manageable than those required by a hard push towards universal access. In addition, its ODA requirement is more modest. The US$22 billion that could be gained in ODA for WASH if it continues growing at the rate seen under the MDGs comes close to covering the US$36 billion in infrastructure spending that

Figure 16: Maps of safe water and adequate sanitation access in the Universal Access and Balancing WASH scenarios, 2030 (small island states excluded)



Source: International Futures 7.18.

Figure 17: Difference in government spending to health, education and infrastructure as a percentage of GDP for Africa, Balancing WASH scenario minus Current Path scenario



Source: International Futures 7.18.

Figure 18: Difference from the Current Path in four key human development indicators for both the Universal Access scenario and the Balancing WASH scenario

Source: International Futures 7.18.

Balancing WASH requires. It is also easier to imagine that countries could cover the remaining amount (US$14 billion, or about US$93 million annually) using other strategies proposed in the Addis Ababa Action Agenda in this scenario. However, the lower monetary cost of Balancing WASH is also associated with poorer human development outcomes and by 2030 it still leaves countries with a long road to travel to fulfil all people's human right to water and sanitation.

Assumptions and limitations

This research adopts a number of assumptions that are important to highlight. Primarily, it assumes that WASH infrastructure equates to WASH access. Policymakers and practitioners should recognise, however, that access is determined not only by the supply of infrastructure, but also by the social relations of inequality that exist in a given community or society. These social relations can differentially influence people's access to WASH facilities and their ability to acquire and control those resources that are necessary to maintain high standards of sanitation and hygiene.[55] This means that the construction of new infrastructure does not guarantee that access will be enjoyed equally by all members of a household or community.[56]

Poverty is one of the best-documented sources of inequity in WASH access – and another is gender. Gender is explicitly mentioned in target 6.2 of the SDGs, which acknowledges the need to pay 'special attention to the needs of women and girls and those in vulnerable situations.'[57] Women and girls have specific needs when it comes to WASH. For instance, they need sanitation facilities that allow for proper menstrual hygiene management; a lack of such facilities has been shown to have negative effects that include voluntary withdrawal from school.[58] Women also bear a disproportionate burden of responsibility for

collecting and managing water for domestic use, which can cost them opportunities to work, attend school, or participate in community activities. However, women's relationship with water can be complex, and their views and those of other vulnerable groups should be taken into account at every stage of WASH planning and programming.[59]

A limitation related to the assumption that infrastructure equates to access is that in modelling WASH infrastructure, this paper does not engage with the debate in the literature over the concept of infrastructure versus services. The proper maintenance of WASH infrastructure requires services that include long-term planning and decision-making, as well as effective governance and management. The per unit maintenance costs of WASH infrastructure are taken into account in the forecasts, but not necessarily the institutional dynamics that can cause WASH programming to succeed or fail.

> Women bear a disproportionate burden of responsibility for managing water for domestic use, which can cost them opportunities to work or participate in community activities

A second assumption in this paper is that access to improved water sources is the same as the consumption of safe water. However, poor water quality and management can nullify the positive human development outcomes of installing infrastructure. The JMP does not monitor water quality, so there is no guarantee that water from improved sources is safe for human consumption. A 2012 study used water-quality data to estimate the number of people with access to 'safe' water in terms of both source and quality, and found that in 2010 1.8 billion people (28% of the global population) were using water sources with faecal contamination. This value was over twice the JMP estimate of 783 (11%) million people using unimproved sources in 2010.[60] Faecal contamination is linked to millions of cases of WASH-related deaths and chronic illnesses each year[61] and is only one of several documented threats to 'improved' water sources; arsenic contamination is another.[62]

In addition to issues of source quality there are management concerns. Many households combine improved and unimproved water sources, especially in rural areas, and improved water can be vulnerable to contamination during transportation and storage; for example, if people dip unwashed hands into drinking water storage containers.[63] The authors of the aforementioned water quality study estimated a revised 1990 baseline that suggests that if the JMP were accounting for quality, the world would not have met the MDG 7's safe water access target. Similarly, uncertainty around water quality, storage and management may mean that access to water that is truly 'safe' may be overstated in this paper, along with its associated human development outcomes.

A final assumption is that countries will rely on 'traditional' forms of water and sanitation to address WASH access (e.g. piped household water connections and flush toilets). However, many countries that have performed especially well in recent years have also experimented with alternative, lower-cost means of expanding access. One example of a lower-cost sanitation strategy is Community-Led Total Sanitation (CLTS), a model that was successfully employed by Ethiopia during the MDG period.

MANY COUNTRIES HAVE SUCCESSFULLY EXPERIMENTED WITH ALTERNATIVE, LOWER-COST MEANS OF EXPANDING WASH ACCESS

CLTS is an approach to expanding rural sanitation access in which, 'people in rural communities are facilitated to do their own appraisal and analysis, come to their own conclusions, and take their own action'.[64] It does not require governments to provide resources for infrastructure, but rather relies on communities to take collective action to address their sanitation needs.

Another option is to include shared facilities that meet appropriate standards in the 'improved' category. Shared sanitation has been shown to be a culturally acceptable and potentially hygienic alternative to other unimproved types of sanitation (e.g. open defecation) in parts of sub-Saharan Africa.[65] IFs forecasts that in 2030 over 200 million people in Africa will have access to shared facilities on the Current Path and in the Balancing WASH scenario, along with 55 million in Universal Access. Some of these shared facilities may already be achieving the human development effects of improved sanitation, while others may be economically upgraded.

Conclusion

The Current Path forecast presented above suggests that reaching the two major targets of SDG 6, universal and equitable access to water, sanitation and hygiene, is a very ambitious goal for many African countries. In response, this paper presents two different approaches to improving access to WASH infrastructure, each with their own benefits and drawbacks. In the Universal Access scenario, Africa grows access at a rate rarely seen historically. As a result, it achieves the goal of universal access to improved water sources and nearly reaches the 97% threshold in sanitation. In the Balancing WASH scenario, the gains in access to WASH infrastructure are less impressive, but they are still significant and come at a lower cost.

This research concludes that universal WASH access will result in major economic and human development benefits, including substantial reductions to infant mortality, percentage of malnourished children, and deaths from diarrhoeal disease. Gains are most pronounced in countries with low access baselines; these countries could see a cumulative increase of over US$350 billion in additional GDP by 2030, along with thousands fewer lives lost to WASH-related illness. But these gains will also come at a cost. The resources required to achieve universal WASH access in Africa are estimated here to be at least US$122 billion cumulatively over the next 15 years. If countries choose to pursue a more moderate approach, on the other hand, they could see around 50% of the benefits of universal access at 30% of the cost.

Achieving universal access will require a diversion of funds away from other sectors. Unless countries are able to access alternative resources (e.g. additional ODA for WASH), aggressively pursuing targets 6.1 and 6.2 could compromise the advancement of a broad-based development agenda. Health and education are two critical sectors that see significant spending cuts in the Universal Access scenario. The forecast horizon used in this paper is unable to fully capture the impacts resulting from these cuts, but they are likely to have detrimental long-term effects on human capital. In light of these findings, this research suggests that Africa's leaders will need to consider both the benefits and the costs (economic and to human development) of WASH as they set national development agendas over the next 15 years.

Appendices

Appendix 1: Full country group list with 2015 levels of water and sanitation access and mean WASH access scores

Group	Country	2015 sanitation access	2015 water access	Mean access score
GROUP A	Seychelles	99.6	95.7	97.7
	Egypt	94.7	99.4	97.1
	Mauritius	93.2	99.9	96.5
	Tunisia	91.6	97.8	94.7
	Libya	95.4	77.7	86.5
	Algeria	87.6	83.6	85.6
	Morocco	76.7	85.4	81.1
	Botswana	63.4	96.2	79.8
	South Africa	66.4	93.2	79.8
	Cape Verde	66.6	91.7	79.1
GROUP B	Gambia	58.9	90.3	74.6
	Rwanda	61.7	76.1	68.9
	Djibouti	47.4	90	68.7
	Gabon	41.9	93.3	67.6
	São Tome and Príncipe	34.7	97.1	65.9
	Swaziland	57.5	74.1	65.8
	Malawi	41	90.2	65.6
	Senegal	47.6	78.5	63.1
	Comoros	35.8	90.1	63
	Namibia	34.4	91	62.7
	Burundi	48	75.9	61.9
	Equatorial Guinea	74.5	47.9	61.2
	Cameroon	45.8	75.6	60.7
	Zimbabwe	36.8	76.9	56.9

Group	Country	2015 sanitation access	2015 water access	Mean access score
GROUP B cont.	Lesotho	30.3	81.8	56
	Zambia	43.9	65.4	54.6
	Cote d'Ivoire	22.5	82	52.2
	Ghana	14.9	88.7	51.8
	Burkina Faso	19.7	82.3	51
	Mali	24.7	77	50.8
GROUP C	Guinea Bissau	20.9	79.3	50.1
	Angola	50.1	49	49.5
	Uganda	19.1	79	49
	Mauritania	40	57.9	49
	Benin	19.7	77.9	48.8
	Nigeria	29	68.5	48.7
	Guinea	20.1	76.8	48.5
	Kenya	30.1	63.2	46.7
	Liberia	16.9	75.6	46.2
	Republic of the Congo	15	76.5	45.8
	Central African Republic	21.8	68.5	45.1
	Ethiopia	28	57.3	42.7
	Sudan	25.5	56.6	41.1
	Democratic Republic of the Congo	28.7	52.4	40.5
	Eritrea	19.1	57.8	38.5
	Sierra Leon	13.3	62.6	38
	Togo	11.6	63.1	37.3
	Mozambique	20.5	51.1	35.8
	Tanzania	15.6	55.6	35.6
	Niger	10.9	58.3	34.6
	South Sudan	6.7	58.7	32.7
	Madagascar	12	51.5	31.8
	Chad	12.1	50.8	31.5
	Somalia	25.1	37.2	31.1

Appendix 2: About the International Futures Model

This paper uses version 7.18 of International Futures. The IFs tool models relationships across variables from a wide range of key global systems for 186 countries from 2010 to the end of the century. Relationships are structured in the model in two interconnected ways: firstly, by leveraging a large set of historical data series from many renowned international data collection organisations (nearly 3 000 series in the most recent version of the model) and, secondly, by relying heavily on academic literature. IFs should not be thought of as purely a forecasting tool, but rather as a dynamic scenario building tool that allows for the modelling of long-term futures concerning development across human, social and natural systems. It is important to think of IFs forecasts as highly contingent scenarios – not predictions.

IFs allows users to perform three types of analysis. Firstly, historical trends and relationships can be analysed to understand how a country has developed over time. Secondly, these relationships are formalised in the model to produce Base Case forecasts. These initial forecasts, which are integrated across all systems covered in IFs, are useful indicators of where a country seems to be heading under current circumstances and policies, and in the absence of major shocks to the system (wars, pandemics, etc.). Thirdly, scenario analyses augment the Base Case analysis by exploring the leverage that policymakers may have to push systems to more desirable outcomes.

Appendix 3: Interventions

In the Universal Access scenario, the authors used a multiplier to move Africa aggressively but consistently towards universal access to both water and sanitation in 2030. For water, we moved the multiplier watsafem to 0 by 2030, simulating a push to 0% of the population with no access to improved sources; the model then determined the proportion of connections that were shared or private, favouring private (household) connections. For sanitation, we moved the multiplier sanitationm to 10 from 2016 to 2030, simulating the most aggressive push possible toward universal access to improved sanitation.

The Balancing WASH scenario was created by using a standard error target to move countries one standard error below the African average for individuals who have no connection to improved water and sanitation. For water, we used the watsafenoconsetar target, set to -1. For sanitation we used the sanitnoconsetar target, set to -1.

Appendix 4: Standard Error Targeting

The Balancing WASH scenario uses a standard error targeting technique. This strategy moves the level of access in water and sanitation infrastructure above or below the 'expected' value a country is forecast to achieve in the Current Path by one standard error above or below the African average. For a more detailed explanation of standard error targeting please see the help section of the Pardee Center website: www.du.edu/ifs/help/understand/equations/specialized/setargeting.html.

Notes

1 See Appendix 2 for a description of the International Futures (IFs) model.

2 The annual access growth rates reported in this paper were calculated by taking the average of the difference between the percent of the population with access in base year and in the most recent year for the given range (2000 to 2015 or 2016 to 2030).

3 To learn more about the African Futures Project (AFP) and access additional publications, see Frederick S. Pardee Center for International Futures, African Futures Project, http://pardee.du.edu/african-futures-project.

4 United Nations (UN) General Assembly, Transforming Our World: The 2030 Agenda for Sustainable Development 2015, Resolution 70/1, New York: UN General Assembly, 25 September 2015, 15, www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

5 Ibid.

6 UN, The Millennium Development Goals Report 2015, www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf.

7 UN General Assembly, Transforming Our World: The 2030 Agenda for Sustainable Development 2015, Resolution 70/1, New York: UN General Assembly, 25 September 2015, 18, www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

8 Ibid.

9 SDG 6 includes several other targets covering issues that are deeply interlinked with targets 6.1 and 6.2. Given the novelty of these targets, however, comprehensive global monitoring is only now being developed under the auspices of UN-Water, in an effort called the Global Expanded Water Monitoring Initiative. We hope to incorporate these targets into our analyses as more data become available. See J Harlin and M Kjellén, Water and Development: From the MDGs toward the SDGs, in A Jägerskog, *Water for Development – Charting a Water Wise Path,* Stockholm: Stockholm International Water Institute (SIWI), 2015, 35, www.siwi.org/publications/2015-world-water-week-report-water-for-development/.

10 World Health Organization (WHO) and UN Children's Fund (UNICEF), WASH POST-2015: Proposed Targets and Indicators for Drinking-Water, Sanitation and Hygiene, 2014, www.wssinfo.org/fileadmin/user_upload/resources/post-2015-WASH-targets-factsheet-12pp.pdf.

11 JMP data for Africa is relatively complete, but in cases where historical values are missing for a given country and/or year the model estimates these before creating forecasts using the data preprocessor. The data preprocessor uses cross-sectional relationships from key variables such as GDP, population, and land area to fill holes in historical series when it initializes the base year of the model, currently 2010. Read more about the preprocessor at IFs, The data pre-processor of International Futures, June 2006, www.ifs.du.edu/assets/documents/preprocessorv1_0.pdf.

12 JMP data is designed to track global progress and to be easily comparable across countries, and may differ from that used by in-country agencies, causing discrepancies between nationally reported figures. These discrepancies can also reflect conflicting incentives among institutions, for instance the desire to show progress versus the desire to emphasize the need for more resources. See J Harlin and M Kjellén, Water and Development: From the MDGs toward the SDGs, in A Jägerskog, *Water for Development – Charting a Water Wise Path,* Stockholm: SIWI, 2015, 35, www.siwi.org/publications/2015-world-water-week-report-water-for-development/.

13 WHO/UNICEF, Joint Monitoring Programme: Improved and Unimproved Water Sources and Sanitation Facilities, www.wssinfo.org/definitions-methods/watsan-categories/.

14 Ibid.

15 Although the most recent JMP data still exclude shared facilities, there is some indication that this may change as data collection improves and monitors are able to determine more precisely if certain shared facilities are sufficient. See T Rheinländer et al, Redefining Shared Sanitation, Bulletin of the World Health Organization 93:7, 2015, www.who.int/bulletin/volumes/93/7/14-144980/en/.

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18 Ibid.

19 Ibid.

20 UN General Assembly, Transforming Our World: The 2030 Agenda for Sustainable Development 2015, Resolution 70/1, New York: UN General Assembly, 25 September 2015, www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

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23 International Council for Science (ICSU) and International Social Science Council (ISSC), Review of Targets for the Sustainable Development Goals: The Science Perspective, Paris: ICSU, 2015, www.icsu.org/publications/reports-and-reviews/review-of-targets-for-the-sustainable-development-goals-the-science-perspective-2015/SDG-Report.pdf.

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27 H Bleakley, Health, Human Capital, and Development, *Annual Review of Economics,* 2, 2010.

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29 In 2015 91% of the world's population had access to safe water and 68% had access to improved sanitation. See WHO/UNICEF, Progress on Sanitation and Drinking Water, *Joint Monitoring Programme on Water and Sanitation*. Geneva: WHO, 2015, www.who.int/water_sanitation_health/monitoring/jmp-2015-update/en/.

30 These regional groups are the Caucasus and Central-Asia, East Asia, Latin America and the Caribbean, Northern Africa, Oceania, Southern Asia, South-eastern Asia, sub-Saharan Africa, Western Asia. See WHO/UNICEF, Progress on Sanitation and Drinking Water, *Joint Monitoring Programme on Water and Sanitation.* Geneva: WHO, 2015, www.who.int/water_sanitation_health/monitoring/jmp-2015-update/en/.

31 Ibid.

32 Ibid.

33 Ibid.

34 WHO/UNICEF Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

35 WHO/UNICEF, Progress on Sanitation and Drinking Water, *Joint Monitoring Programme on Water and Sanitation.* Geneva: WHO, 2015, www.who.int/water_sanitation_health/monitoring/jmp-2015-update/en/.

36 Ibid.

37 It was surprisingly difficult to identify a precise definition of 'universal' access under the SDG framework, but WaterAID, a leading international WASH non-governmental organisation, has suggested a 100% threshold for targets 6.1 and 6.2. See WaterAID, Measuring what matters: analysis and proposals for indicators on water, sanitation and hygiene (WASH) in the Sustainable Development Goals (SDGs), *Briefing Note,* May 2015, www.wateraid.org/~/media/Publications/Measuring-what-matters-Indicators-WASH-in-the-post-2015-framework.pdf.

38 MDG Monitor, MDG 2: Achieve Universal Primary Education, 26 September 2015, http://www.mdgmonitor.org/mdg-2-achieve-universal-primary-education/.

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40 Please see Appendix 1 for a full country list for each cohort, including 2015 water and sanitation access levels.

41 All averages reported at the group level are weighted based on the populations of the countries included in each group.

42 In addition to historical development trends, these scenarios judge the ability of African countries to meet SDG 6.1 & 6.2 based on levels of current access and potential financial resources. However, they say nothing about political will and there is reasonable skepticism about the ability of resource rich and/or conflict affected countries to efficiently disperse available funds toward a comprehensive development agenda such as the SDGs.

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44 WHO/UNICEF Joint Monitoring Programme, 2016, http://www.wssinfo.org/data-estimates/tables/.

45 Ibid.

46 A 2011 policy brief released by AFP called 'Taps and Toilets' estimated than an 'aggressive but reasonable' annual improvement in water and sanitation access of 1.9 percentage points per year would lead to a US$75 billion increase in GDP in 2040. This increase came at a cost of US$35 billion in infrastructure spending over 40 years. However, the results in this paper are different from those in 'Taps and Toilets' because it targets the more expensive forms of infrastructure required by SDG 6 over a shorter time horizon. See M Eshbaugh et al, Taps and Toilets: How Greater Access can Radically Improve Africa's Future, African Futures, Brief 1, 2011, www.pardee.du.edu/sites/default/files/taps%20and%20toilets.pdf.

47 IFs uses the term 'malnourished' to refer to undernourishment; this variable does not capture other forms of malnourishment, such as obesity.

48 IFs takes service maintenance into account in infrastructure spending, estimating an annual per unit maintenance cost of 1.74% of piped household water and sanitation connections, and 3.47% for shared water sources. See D Rothman et al, Building Global Infrastructure: Forecasting the next 50 years,Patterns of Potential Human Progress, vol. 4, Boulder: Paradigm Publishers, 2014, 99.

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50 Investment in education is routinely identified as the primary driver of human capital, although the full benefits of education spending cannot be fully realized within a single generation. For example, moving from 10% primary completion to 90% has been shown to take an average of 88 years, and similar improvements at higher levels of education will be even more protracted. See A Wils, B Carrol and K Barrow, Educating the World's Children: Patterns of Growth and Inequality, Education Policy and Data Center (EPDC), Working Paper, Washington DC: EPDC, 2005, in J Dickson, B Hughes and M Irfan, *Potential Patterns of Human Progress Volume 2: Advancing Global Education,* Boulder: Paradigm Publishers, 2010.

51 UN-Water and WHO, Investing in Water and Sanitation: Increasing Access, Reducing Inequalities, 2015, http://apps.who.int/iris/bitstream/10665/204276/1/WHO_FWC_WSH_15.05_eng.pdf.

52 UN General Assembly, Transforming Our World: The 2030 Agenda for Sustainable Development 2015, Resolution 70/1, New York: UN General Assembly, 25 September 2015, 26, www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

53 UN, Addis Ababa Action Agenda of the Third International Conference on Financing for Development (Addis Ababa Action Agenda), 2015, www.un.org/esa/ffd/wp-content/uploads/2015/08/AAAA_Outcome.pdf.

54 The Balancing WASH scenario uses standard error targets to accelerate WASH access; see the Appendix for a brief description of this approach to modelling.

55 F Cleaver and K Hamada, 'Good' Water Governance and Gender Equity: A Troubled Relationship, *Gender & Development* 18:1, 2015.

56 For example, research in rural Zambia found that when a new borehole was installed, its governance quickly succumbed to local power dynamics. The project was devised to provide safe drinking water to an entire rural community, including its poorest members. Soon after its installation, however, elite landowners were able to use their political influence to appropriate the water for their cattle, pushing the poorest (landless) members of the community back to old, unsafe sources for drinking water. See M Funder et al, Strategies of the Poorest in Local Water Conflict and Cooperation: Evidence from Vietnam, Bolivia and Zambia, *Water Alternatives,* 5:1, 2012.

57 UN General Assembly, Transforming Our World: The 2030 Agenda for Sustainable Development 2015, Resolution 70/1, New York: UN General Assembly, 25 September 2015, 18, www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

58 A study from Malawi, for instance, found that only 46% of girls who reached menarche before age 14 completed primary school, compared to 70% who reached it after 16 years of age due to a lack of appropriate menstrual hygiene management resources. See M Sommer, Menarche: A Missing Indicator in Population Health from Low-Income Countries, *Public Health Reports,* 128:5, 2013.

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About the African Futures Project

The African Futures Project is a collaboration between the Institute for Security Studies (ISS) and the Frederick S. Pardee Center for International Futures at the Josef Korbel School of International Studies, University of Denver. The African Futures Project uses the International Futures (IFs) model to produce forward-looking, policy-relevant analysis based on exploration of possible trajectories for human development, economic growth and socio-political change in Africa under varying policy environments over the next four decades.

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The Institute for Security Studies is an African organisation that aims to enhance human security on the continent. It does independent and authoritative research, provides expert policy analysis and advice, and delivers practical training and technical assistance.

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African Futures Paper 17

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