WASH
Poverty Diagnostic | SERIES

WASH Poor in a Water-Rich Country

A Diagnostic of Water, Sanitation, Hygiene, and Poverty in the Democratic Republic of Congo

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Acknowledgments

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Executive Summary

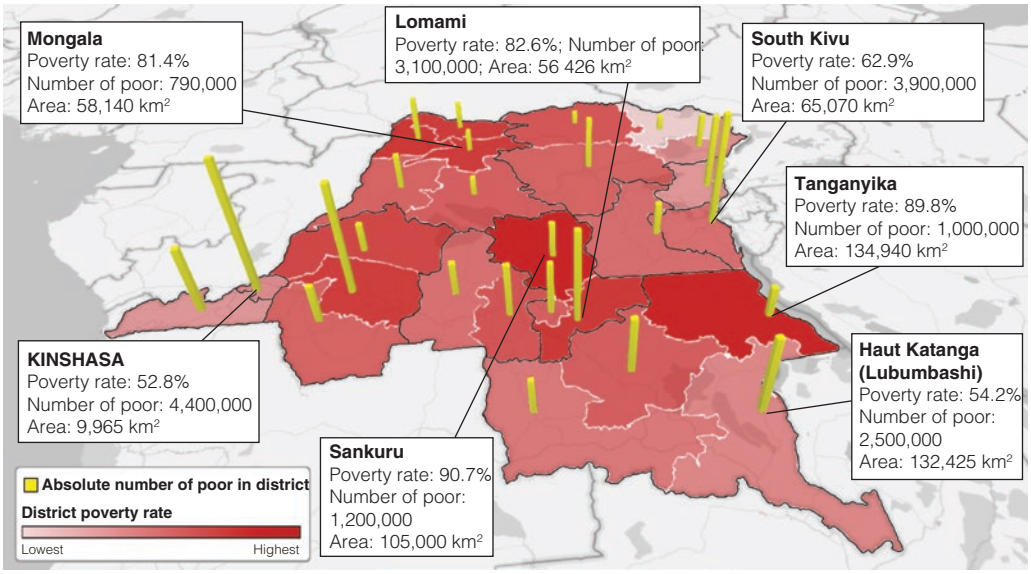
The Water, Sanitation, and Hygiene Poverty Diagnostic (WPD) in the Democratic republic of Congo is part of a global initiative to improve evidence on the linkages between WASH and poverty. The diagnostic provides a detailed analysis of sector status, strengths, and weaknesses to inform the attainment of the new Sustainable Development Goals (SDGs) that aim for universal access to safely managed water and sanitation.

Poverty in the Democratic Republic of Congo

The Democratic Republic of Congo has the third highest poverty rate in the world and concentrates the fifth largest number of poor people within its borders. The number of poor people in the Democratic Republic of Congo has increased by over 7 million since 2005, driven by the second highest fertility rate in Africa. Poverty rates remain in excess of 80 percent in the forested northwest and inaccessible central Democratic Republic of Congo and are above 50 percent even around major agglomerations, such as Kinshasa and Lubumbashi, which concentrate millions of poor (map ES.1). Indeed, a striking characteristic of price-level adjusted poverty in the Democratic Republic of Congo is that overall it is almost as high in urban areas (62.5 percent) as it is in rural zones (64.9 percent), and is particularly extreme in small towns (81 percent), which are labor abundant, capital deficient, ill-connected, and marred by widespread un- and under-employment.

Multidimensional poverty is high and human development indicators are among the lowest in the world. Despite improvement over the past decade, the Democratic Republic of Congo continues to rank at the bottom of the United Nations (UN) Human Development Index and

Map ES.1: Poverty Rate (Percent) and Absolute Number of Poor in 26 New Provinces



Source: Enquête 123, 2012.
Note: Former province boundaries in black.

other indicators of multidimensional poverty (OPHI 2016). The Democratic Republic of Congo has low life expectancy (58 years) and child mortality in excess of even the Sub-Saharan average (World Bank 2016c).

The scope of the Democratic Republic of Congo for diversifying its economy and investing in human capital through education, health, and basic services, such as WASH, is narrow. Many of the key drivers of the Democratic Republic of Congo's post-war growth are now under threat. A constitutional crisis threatens broader peace, residual armed conflict festers in central and eastern Democratic Republic of Congo, and public resources are under pressure from low prices and transactional politics. At the same time, the universal access targets of the new SDGs require major efforts, given the present situation of WASH services in the Democratic Republic of Congo. The Democratic Republic of Congo may be the ultimate test for the World Bank's twin goals of ending extreme poverty and promoting shared prosperity, and the realism of the new SDGs.

WASH Services in the Democratic Republic of Congo

Access to improved WASH services is low in the Democratic Republic of Congo and has barely improved over the past decade. Improved water facilities are available to only 52 percent of the population and less than 29 percent have access to improved sanitation (UNICEF and WHO 2015). These access rates are substantially below Sub-Saharan averages. Access to both improved water and sanitation has risen by barely 3 percent since the first democratic elections in 2006 and the Democratic Republic of Congo missed the 2015 Millennium Development Goals (MDGs) for WASH. In the same period, due to rapid population growth, the total number of Congolese lacking access to improved water and sanitation facilities increased by more than a quarter to over 35 million and 53 million, respectively.

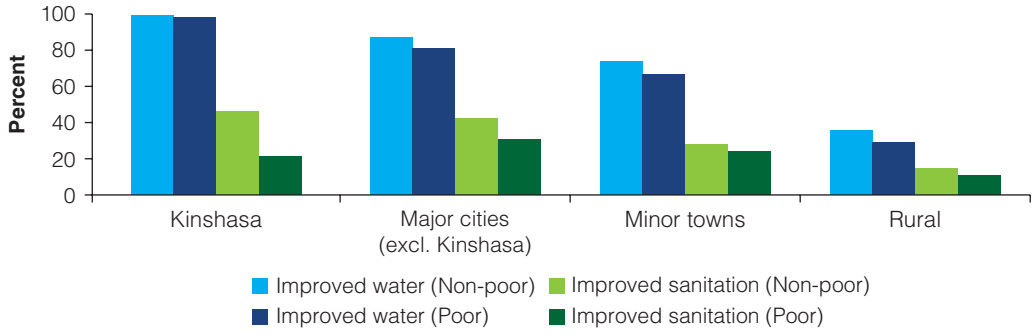
Urban areas have much higher access to improved water sources than rural zones, while differences in improved sanitation access are more compressed at lower levels. Improved water access in cities towers at 81 percent compared to only 31 percent in rural areas. However, urban access has been eroding over the past decade in the face of rapid urbanization. Large access inequalities exist between major cities and more marginal urban areas. In the sanitation sector, long-term aggregate trends indicate nearly equivalent low access rates of approximately 28.5 percent in urban and 28.7 percent in rural areas, with a negative urban trend contrasted by positive rural access improvements over the past decade (UNICEF and WHO 2015). Open defecation is more common in rural areas, though remains below 20 percent, a relatively low value in the regional context.

The poor in the Democratic Republic of Congo have significantly less access to improved water and sanitation than the wealthier. Access to improved water and sanitation is almost 10 percent lower among the poor than the non-poor. Stratification of access increases with wealth: among the top 10 percent of wealthiest households, over 95 percent have access to improved water and almost 35 percent to improved sanitation, but only 22 percent and 17 percent of the bottom 40 percent, respectively. Location is critically important: the poor in larger cities tend to have much better WASH services than small-town and rural households at the same or even higher level of income (figure ES.1).

The New Sustainable Development Goals (SDGs) and the Water Quality Problem

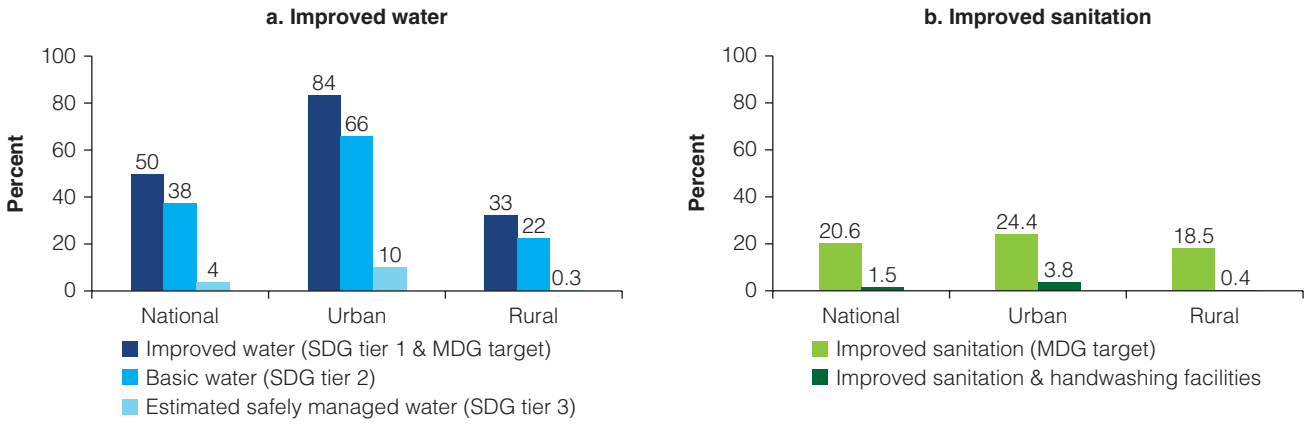
The SDGs set ambitious new targets for WASH: universal access to truly safe facilities by 2030. In the new framework, the aim is to provide all Congolese people with water sources that are not only technically "improved" as the MDGs targeted, but on premises, continuously available, and free of contamination. For sanitation, the new SDG target also goes beyond the MDG aim of non-shared "improved" facilities and, in addition, requires a handwashing facility with water

Figure ES.1: Access to Improved Facilities, by Poverty Status, for Kinshasa, Other Major Cities, Minor Towns, and Rural Zones



Source: Enquête 123, 2012.

Figure ES.2: Current Improved Access to Water and Sanitation Compared with SDG Water and Sanitation Access Tiers



Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2014.
Note: MDG = Millennium Development Goal; SDG = Sustainable Development Goal.

and cleansing agent, as well as the safe disposal of fecal matter. As figure ES.2 illustrates, such high-quality access is currently very rare in the Democratic Republic of Congo.

Setting the bar higher is necessary, however, because "improved" sources are just not safe enough. The WPD carried out water quality tests across the Democratic Republic of Congo showing extremely widespread fecal contamination even of sources that are "improved" according to the definition of the Joint Monitoring Programme of the World Health Organization and UNICEF. More than a third of piped water tested in Kinshasa was contaminated with *Escherichia coli* at point of use, and in some provincial towns and rural areas contamination of improved water exceeded 80 percent of tested samples. Similarly, few households have handwashing facilities with soap, and even the biggest cities of the Democratic Republic of Congo lack fecal sludge treatment sites. Thus, most fecal sludge from improved toilets is ultimately dumped unsafely or leaks into the environment. This contamination is a critical problem and has contributed to a silent emergency of malnutrition.

A Silent Emergency: Malnutrition and Its Link to Poor WASH

A silent emergency is placing Democratic Republic of Congo's poor and rapidly growing population at risk of permanent disconnect: widespread malnutrition, to which WASH is a key contributing factor. Food insecurity and malnutrition are rampant in the Democratic Republic of Congo. Data from the latest (2014) Demographic and Health Survey (DHS) (Enquête Démographique et de Santé [EDS]) reveals that a staggering 43 percent of Congolese children under five years are chronically malnourished (figure ES.3). A survey conducted by the WPD showed just how widespread anxiety about nutrition is. Even in Kinshasa, in 2016, almost 60 percent of the non-poor and over 75 percent of the poor had worried about not having enough to eat over the past 12 months.

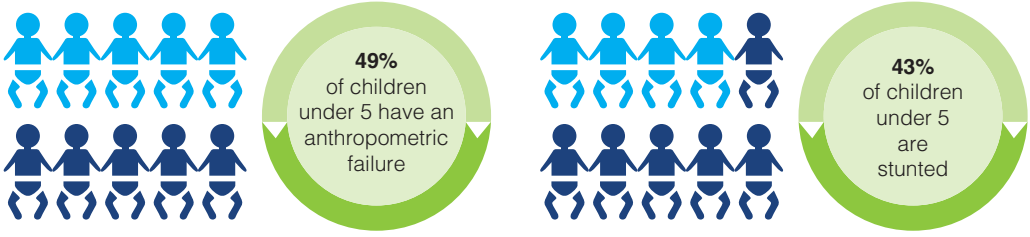
Malnutrition is an acute and long-term health risk and is linked to poor WASH. Stunting is a powerful risk factor and is associated with 53 percent of infectious disease-related deaths in developing countries. Malnutrition can also have long-lasting negative effects, including a reduced capacity for manual work, poor mental development, and behavioral abnormalities. This risks long-term disadvantages for affected individuals and compromises the development of the Democratic Republic of Congo as a whole. A growing literature shows how poor WASH contributes to malnutrition by transmitting pathogens and infections that inhibit nutritional uptake through diarrhea, parasites, enteric inflammation, and dysfunction (Cumming and Cairncross 2016).

This diagnostic confirms that unsafe WASH is closely related to morbidity and mortality in the Democratic Republic of Congo. WASH is one of the top five risk factors associated with death and disability in the country (IHME 2015). The WPD survey data provides evidence for a significant reduction in the probability of stunting among children under five years old in households with access to safely managed water (SDG Target Tier, free of contamination). A significant link between poor WASH access and anemia, which reinforces other WASH-related malnutrition effects, is also shown. These links highlight the importance of the SDG's focus on water quality and the sanitation service chain to truly improve human health and long-term development.

Focusing on Core WASH Service Challenges and Their Institutional Origins

Progress toward the SDGs will require a focus on core WASH service gaps. In the water sector, four challenges stand out: the erosion of urban supply in the face of rapid urbanization, the inequality in access between major cities and marginal urban areas on the one hand, and rural zones on the other, as well as the cross-cutting problem of water quality. In the sanitation

Figure ES.3: Pervasive Malnutrition in Democratic Republic of Congo



Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2014; World Bank calculation.

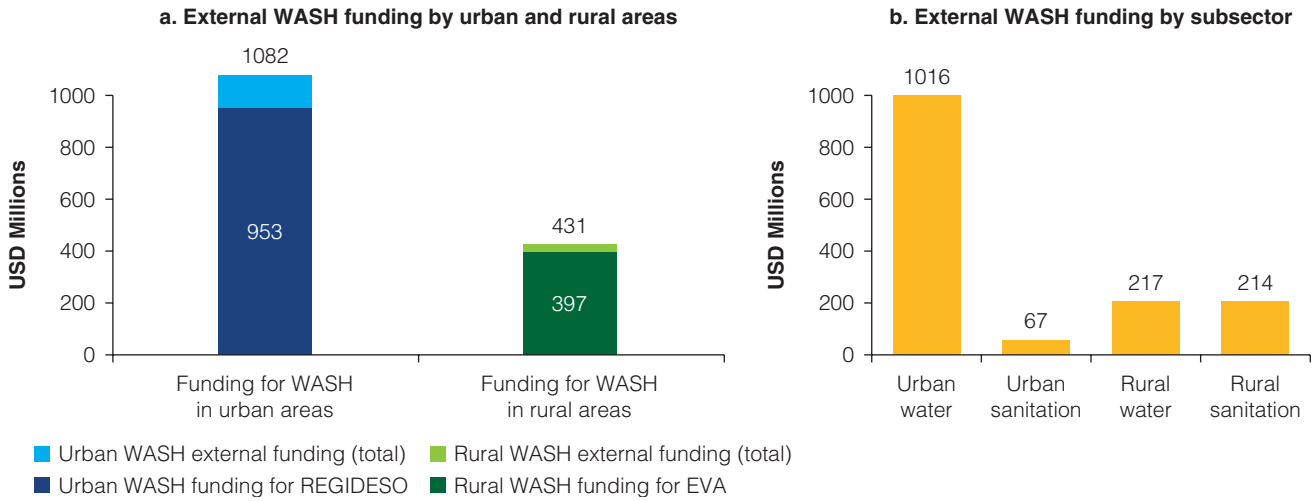
sector, the rural *Ecoles et Villages Assainis* ([EVA] Healthy Schools and Villages) program has led to progress, but is struggling to scale and sustain results. In cities, decades of neglect have led to a near total absence of public services. These gaps cannot be closed by more finance alone, but require new efforts to create institutions that can deliver safely managed WASH services in the long run.

The institutional structure of the Democratic Republic of Congo's WASH sector continues to be characterized by three interlinked challenges: institutional fragmentation, capacity gaps, and a bias toward specific institutions and services. The WASH sector remains split between seven ministries, reducing the efficiency and coherence of policy making and implementation. Capacity gaps are a critical problem, especially as a decentralization process has increasingly shifted responsibilities to underresourced and inexperienced local governments. In an overall divided, underresourced, and low-capacity sector, the limited finance available has been biased to two institutional channels: the urban water utility *Régie de Distribution d'Eau* (REGIDESO) and the EVA program led by UNICEF and the Ministry of Public Health (figure ES.4) and associated services.

Concentrating sparse funds in this manner has a strong justification, but also clear challenges. Given sector fragmentation, low absorption capacity, and almost universally high needs, it is rational to maximize impact by focusing on the relatively best-equipped counterparts or programs and pick low-hanging fruit. A consequence of this strategy, however, has been a focus on subsectors and geographic areas that are already better served, and a perpetuation of the weakness of disadvantaged institutions and service areas.

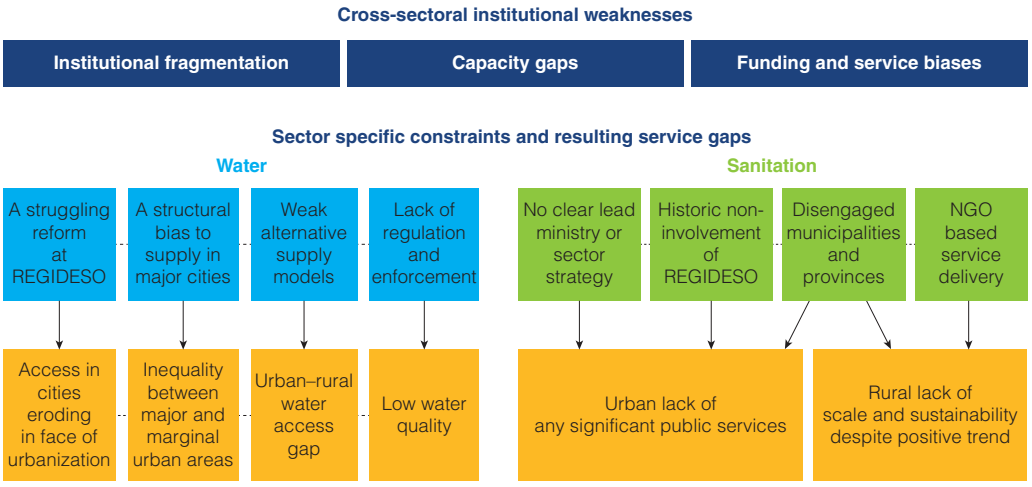
Core service challenges are thus linked to institutional weaknesses. The erosion in urban water supply and increasing gaps between major and minor cities are directly related to the concentration of funds on REGIDESO, which is struggling to reform itself and reach beyond its traditional service centers. The weakness of alternative supply models and rural institutions has further aggravated REGIDESO's limitations, while the lack of policy leadership and regulation has prevented even a systematic understanding of the scale of water quality problems, much less enforcement. Urban sanitation services are nonexistent due to the lack

Figure ES.4: External Funding for WASH, by Urban or Rural Area and Subsector (Disbursements and Commitments, 2005–20)



Source: World Bank calculation.
Note: EVA = Ecoles et Villages Assainis (Healthy Schools and Villages Program). REGIDESO = Régie de Distribution d'Eau (National Urban Water Distribution Agency). WASH = water, sanitation, and hygiene.

Figure ES.5: Cross-Sectoral and Sector-Specific Institutional Constraints and Key Resulting Service Gaps



Note: NGO = nongovernmental organization; REGIDESO = Régie de Distribution d'Eau (National Urban Water Distribution Agency).

of policy leadership, disengaged municipalities, and historic non-involvement of REGIDESO, which limit the implementation capacity of the subsector. While the EVA program has done better in attracting funds to rural areas, it has struggled to sustain and scale-up results due to weak ownership and lack of support from rural state institutions for its NGO-driven service-delivery model. These core institutional weaknesses, main sector specific constraints and resulting service gaps are summarized in figure ES.5.

The New Water Law as an Opportunity for Change

A new Water Law and Policy (2015–16) offer a unique opportunity for the sector, providing reform momentum and a legal basis to address many of the institutional weaknesses that underlie service gaps. The impact of the new Water Law and associated policy on the institutional structure is potentially profound. A dedicated water ministry, regulator, and potential re-ordering of the sanitation sector could decisively reduce fragmentation and provide stronger leadership on issues such as water quality. The recognition of the principle of at-cost tariffs could improve cost recovery, while investments in marginal urban areas could be boosted by the shift of responsibility for infrastructure to provincial governments, and support for delegated management and autonomous systems. Decentralization of responsibility could also strengthen local government's role in donor-financed rural WASH programs. A key challenge will be realizing the law's potential in face of an entrenched sector structure and complex political reality.

The law's implementation must navigate not only the complexity and inertia of the Democratic Republic of Congo's vast state apparatus during an ongoing political crisis, but an incomplete decentralization effort. The 2006 Constitution defined the Democratic Republic of Congo as a unitary, but decentralized state and the number of provinces increased from 11 to 26 in the process. Yet, the decentralization agenda remains incomplete. Provincial revenues have consistently been below the mandated share and central government has continued to assert its authority, leaving new local government entities with limited means and capacity to govern and deliver basic services such as WASH. Realizing the law's potential in this context will be no mean feat.

A Country at the Crossroads

The Democratic Republic of Congo is at a major crossroads: after a decade of little progress, the country must rise to the challenge of the SDG targets in a context of state fragility, high poverty, demographic growth, and urbanization. While the challenge is immense, making significant progress is critical to avoiding a permanent disconnect of the country's vulnerable population. The analysis and key recommendations of this diagnostic suggest priorities for government and its partners to focus their efforts and maximize the chance of real improvement in the WASH sector and, thus, human health and development.

Key Facts and Messages

The most important facts and messages emerging from the Democratic Republic of Congo WASH Poverty Diagnostic, which provide a basis for further awareness raising, planning, and discussions with sector stakeholders, are the following:

Fact 1: Drinking water quality is low across the Democratic Republic of Congo and responsible for negative health outcomes.

Poor water quality is a core service gap at the heart of the Democratic Republic of Congo's WASH challenges. Low quality of supply and treatment, low levels of sanitation access, fecal pollution of the environment, as well as unsanitary handling and storage of drinking water by households conspire to cause widespread contamination. The WASH Poverty Diagnostic shows that pollution of water with *E. coli* at point of use is common across improved and unimproved sources, is high in the capital Kinshasa, and near universal in some rural areas. This contributes to extraordinarily elevated levels of water-related disease and child malnutrition and thus represents a direct threat to human health and development in the Democratic Republic of Congo.

Message 1: Prioritize water quality in line with the new SDG targets. The new WASH SDG targets emphasize quality of access. Eliminating water contamination is the most important aspect of this. Water quality needs to be prioritized at all levels, from the normative-regulatory to programs and project implementation. Water quality should be a focus of the expected new water ministry and regulator. Donor interventions should explicitly target water *quality* instead of only access, as contaminated "improved" facilities are part of the problem. Approaches integrating water with sanitation improvements are critical to reduce cross-contamination. Monitoring of water quality must become more common and integrated into projects, facilitated by simple, cheap new testing technology, such as the one used by this diagnostic. Until reliable infrastructure is in place, fail-safe interventions directly targeting water quality, such as point-of-use treatment, may help alleviate health impacts among the most vulnerable.

Message 2: Strengthen cross-sectoral coordination around the core issue of child malnutrition. Child malnutrition is one of the most serious long-term health threats to which poor water quality contributes, along with other key factors such as food security and education. Focusing on child malnutrition can be a cross-sectoral rallying point for a forward-looking, consensus-building approach to maximizing the impact of WASH interventions. A new WASH Poverty Risk

Model (PRM) developed by this diagnostic shows where in the Democratic Republic of Congo children can benefit most from WASH improvements.

Fact 2: Access to sanitation is lagging behind access to water and is a particularly grave health risk in urban areas.

Access to improved sanitation is significantly lower than access to water. Handwashing and safe disposal of fecal sludge, as targeted by the SDGs, are virtually unknown. This is a particularly public health risk in densely settled, rapidly growing cities, such as the capital Kinshasa, which has recently suffered an unprecedented cholera outbreak. Decades of public inaction have seen the number of urban dwellers without improved sanitation rise from barely 6 million in 1975 to over 30 million today.

Message 3: Break with decades of inaction in urban sanitation. A comprehensive solution to the urban sanitation problem in the Democratic Republic of Congo is unlikely in the medium term due to limited financing and absorption capacity. However, it is critical to lay the foundation for larger-scale future action by resolving institutional fragmentation and breaking with decades of public inaction. The new Water Law foresees a ministerial decree to fix "norms, responsibilities, and organization of the development, management, functioning, and financing of public sanitation." This is an opportunity to re-order policy leadership, clearly assign implementation responsibility to municipal level, and pilot well-defined, replicable projects targeting a clear local impact and commencing a cycle of institutional and service improvement. Communication programs to better convey the health threat of unsafe WASH should be an integral part of any such pilots.

Fact 3: Inequalities in WASH access persist between major cities, marginal urban areas, and rural zones.

In the Democratic Republic of Congo, location is a critical determinant of improved water and sanitation access. The poor in major cities tend to have better access than the non-poor in marginal towns and rural areas. This is due to network effects, as well as the concentration of public investments on key agglomerations. While concentrating scarce resources can be efficient, a consequence is the perpetuation of the weakness of disadvantaged institutions and service areas. Improving the quality of supply in fast-growing major cities will remain critical, but achieving the universal access target of the SDGs will be impossible without a more balanced and effective approach in peri-urban areas, secondary towns, and the vast rural hinterlands.

Message 4: In the urban WASH sector, seize the opportunity to leverage complementary investment channels that can help respond to the growing needs of an expanding urban population. The new Water Law not only supports the reform of the national utility with its emphasis on decentralization and cost recovery, but also allows underserved urban areas to be targeted more directly through alternative investment channels beyond REGIDESO. The law supports investments through decentralized provinces, allows delegated management models

with private or public operators, and recognizes user-managed autonomous schemes. This ends REGIDESO's privileged legal position, heightens competitive pressure, and increases investment opportunities. Donors should provide support to piloting alternative, decentralized investment channels.

Message 5: In the rural WASH sector, re-organize and strengthen provincial WASH departments. The EVA Program has reached up to 10 percent of the rural population with WASH interventions, but its NGO-driven implementation model has struggled to sustain its impact and scale up further. Sustainability has been a particular concern with up to 80 percent of intervention sites not maintaining the improved sanitation target at first revisit. To increase absorption and sustainability, local government institutions—now formally empowered through the Water Law—must build their capacity. In a country of the Democratic Republic of Congo's size, a scale-up toward the SDG universal access targets cannot be realized without a sustained strengthening of local governments. This should be reinforced with better prioritization of intervention sites, continued cost control, a wider array of technologies (including small piped schemes where appropriate) and cross-sectoral interventions to achieve maximum impact at minimum costs.

Fact 4: The new Water Law creates a legal basis for addressing long-standing institutional weaknesses.

The new Water Law and associated Water Policy provide a specific legal framework for the WASH sector in the Democratic Republic of Congo for the first time. This framework gives a strong basis for major institutional reforms including a dedicated water ministry and regulatory authority, the decentralization of WASH investments, the separation of asset ownership and delegated service provision, the recognition of autonomous systems managed by user associations, and the principle of at-cost tariffs. This presents an opportunity to start addressing long-standing sector weaknesses, such as institutional fragmentation, over-centralization of service provision, lack of regulation, and the absence of cost recovery, which have constrained services.

Message 6: Strengthen institutional ownership of the new Water Law to maintain its momentum. Implementing the new Water Law and Policy will require wide-ranging changes to an entrenched sector structure. This is difficult not only due the size, complexity, and inertia of the Democratic Republic of Congo's vast state apparatus, but also the ongoing constitutional crisis that has diverted political energy away from ambitious reforms. To maintain the momentum of the law, a dedicated implementation unit should be supported within the Ministry of Energy and Water Resources. This unit should draw up concrete proposals to prepare the institutional reorganization, draft the decrees envisaged in the law, advise provincial governments and counterparts on its implications, mediate conflicts arising from its application, resist attempts to circumvent the law, support pilot investment projects in line with the law's innovations, and act as core future water ministry and proto-regulator. The issue of water quality could be a natural first thematic focus.

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Abbreviations

ACLED	Armed Conflict Location and Event Data
ADIR	Action Développement et Intégration Régionale
AFD	Agence Française de Développement (French Development Agency)
ASUREP	Association des Usagers des Réseaux d'Eau Potable (Users Association of Drinking Water Networks)
B40	bottom 40 percent
CIAF	composite index of anthropometric failures
CLTS	community-led total sanitation
CNAEHA	Comité National 'Action de l'Eau, de l'Hygiène et de l'Assainissement (National WASH Action Committee)
COPIREP	Committee for the Reform of Public Enterprises
DALY	disability-adjusted life year
DAS	Direction d'Assainissement (Directorate of Sanitation)
DfID	Department for International Development (UK)
DH	Directorate of Hygiene
DHS	Demographic and Health Survey
EVA	Ecoles et Villages Assainis (Healthy Schools and Villages Program)
ETD	Entités Territoriales Décentralisées (Decentralized Territorial Entities)
FBEI	Fonds du Bien-être Indigène (Indigenous Welfare Fund)
FEDASU	Fédération des associations des réseaux d'eau potable (Federation of Water Network Associations)
FONAK	Fonds d'assainissement pour la ville de Kinshasa
GBD	global burden of disease
GPW	gridded population of the world
HAZ	height-for-age *Z*-scores
HOI	Human Opportunity Index
IDA	iron-deficiency anemia
INS	Institution National de la Statistique
JMP	Joint Monitoring Program
LSHTM	London School of Hygiene and Tropical Medicine
LSMS	Living Standards Measurement Survey
MDG	Millennium Development Goals
MECNDD	Ministère de l'Environnement, Conservation de la Nature et Développement Durable (Ministry of Environment, Conservation of Nature and Durable Development)
MEWR	Ministry of Energy and Water Resources

MICS	multi-indicator cluster survey
MoE	Ministry of Education
MPH	Ministry of Public Health (Ministère de la Santé Publique)
ORT	oral rehydration treatment
PEMU	Projet d'Alimentation en Eau Potable en Milieu Urbain (IDA Urban Water Supply Project)
PNHAB	Politique Nationale de l'Hygiène et d'Assainissement de Base (National Sanitation and Hygiene Policy)
PNSPE	Politique Nationale du Service Public de l'Eau (National Public Water Service Policy)
PPS	probability proportional to size
PONA	Politique Nationale d'Assainissement (National Sanitation Policy)
PRM	poverty risk model
PSU	primary sampling unit
QUIBB	Questionnaire des Indicateurs de Base du Bien-être
RATPK	Régie d'assainissement et des travaux publics de Kinshasa (Kinshasa Sanitation and Public Works Agency)
REGIDESO	Régie de Distribution d'Eau (National Urban Water Distribution Agency)
RR	relative risks
RSU	remote sensing unit
SDG	Sustainable Development Goals
SNHR	Service National d'Hydraulique Rurale (National Rural Water Service)
SWIFT	Survey of Well-being via Instant and Frequent Tracking
T60	top 60 percent
UF	University of Florida
UNICEF	United Nations Children's Fund
WASH	water, sanitation, and hygiene
WDR	World Development Report
WFA	weight for age
WHO	World Health Organization
WiN	WASH-in-nutrition
WPD	WASH poverty diagnostic
YLD	years lost due to disability

Chapter 1
Introduction

The Water, Sanitation, and Hygiene (WASH) Poverty Diagnostic (WPD) in the Democratic Republic of the Congo is part of a global initiative with the objective of improving the evidence on the linkages between WASH and poverty, as well as identifying opportunities and bottlenecks in the sector. Following the structure of all WASH WPDs, this diagnostic aims to answer four core questions:

- Who and where are the poor and bottom 40 percent of the national distribution (consumption)?
- What is the level of access and quality of WASH services experienced by the poor and bottom 40 percent as compared to the non-poor and the top 60 percent?
- What are the linkages and synergies between WASH and other sectors?
- What are the WASH service-delivery constraints and potential solutions to improving services to the poor and bottom 40 percent?

To answer these four core questions, the WPD has undertaken an unprecedented review of the existing literature and data (see appendix D for a list of surveys reviewed), complemented by in-depth original research. The WPD interviewed dozens of key sector stakeholders, held 21 focus group discussions with men, women, and adolescents across the country, and carried out household surveys and water-quality testing in Kinshasa, the city of Kindu, and rural small towns in South Kivu and Equateur provinces. The WPD survey interviewed more than 6,000 Congolese households and tested more than 3,500 water samples to obtain quantitative evidence linking household poverty, child anthropometric outcomes, and WASH access and quality for the first time in the Democratic Republic of Congo context.

The methodological approach of the WPD stressed cross-sectoral links from the start, in particular with the health sector, due to the high relevance of health impacts of poor water, sanitation, and hygiene on long-term human development. The WPD worked with World Bank health teams in the Democratic Republic of Congo to collect additional data through health surveys in North and South Kivu, as well as an international team from the London School of Hygiene and Tropical Medicine (LSHTM), Overseas Development Institute (ODI), and University of Florida (UF) to develop new risk models. The outcomes of these collaborations are captured in chapter 3 and in the conclusions of the diagnostic.

By answering the four core questions, the WPD aims to provide a comprehensive analysis of the current state of WASH in the Democratic Republic of Congo and strategies for improving outcomes, in particular for the poorest. As noted by the International Monetary Fund (IMF) in a recent analysis, investment in the water and sanitation infrastructure of the Democratic Republic of Congo is a key channel for enhancing the inclusiveness of growth in the country (IMF 2015a). The service gaps in the WASH sector present a clear opportunity to improve the quality of life of the population in one of Africa's most rapidly growing economies.

As the ambitious new Sustainable Development Goals (SDGs), which aim for universal access to safe water and sanitation, raise the bar for the WASH sector, the Democratic Republic of Congo exemplifies the breadth and depth of the challenge. The present report aims at providing a data-driven diagnostic to inform the way forward.

A full list of research outputs associated with this WASH Poverty Diagnostic is provided in appendix A.

Reference

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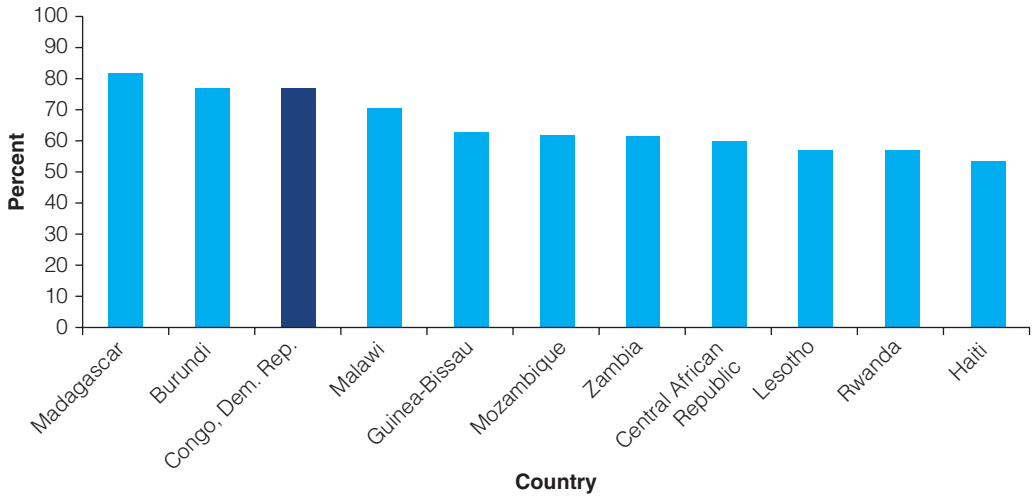
Chapter 2
Poverty in the Democratic Republic of Congo: The Heart of the Challenge

Key Points

- The Democratic Republic of Congo is among the five poorest countries in the world, whether measured by poverty rate or number of poor. The Democratic Republic of Congo is thus at the heart of the World Bank's mission to end extreme poverty.
- Water, sanitation, and hygiene (WASH) is a leading contributor to multidimensional poverty in the Democratic Republic of Congo.
- Despite a slight improvement in poverty rates between 2005 and 2012, the total number of poor has increased by 7 million during the same period, towering to a total of 45 million.
- Rapid demographic growth—the second highest in Africa—has driven the increase in the total number of poor and puts extreme pressure on the country's derelict infrastructure.
- A striking characteristic of the Democratic Republic of Congo is that poverty is almost as high in urban (62.5 percent) as in rural (64.9 percent) areas, and smaller cities tend to be much poorer than the largest cities of the Democratic Republic of Congo.
- The pervasive nature of poverty in the Democratic Republic of Congo confounds an easy prioritization of pro-poor interventions. The new Sustainable Development Goals (SDGs) aim for universal access to basic amenities such as WASH, which will pose a major challenge for the allocation of scarce resources in the short term and require unprecedented investments to achieve in the long term.

The Democratic Republic of Congo has the third highest poverty rate in the world and concentrates the fifth largest number of poor people within its borders. Measured by the purchasing power parity adjusted international poverty line of USD 1.9 per day, only Burundi and Madagascar have a higher poverty rate (figure 2.1). More poor people live only in Bangladesh, China, India, and Nigeria (World Bank 2016b). The Democratic Republic of Congo is thus at the heart of the challenge to ending extreme poverty and boosting shared prosperity globally.

Figure 2.1: Poverty Rates, Selected Countries, 2016



Source: World Bank 2016b.
Note: Estimates based on the USD 1.90 poverty line and 2011 purchasing power parity (PPP) prices.

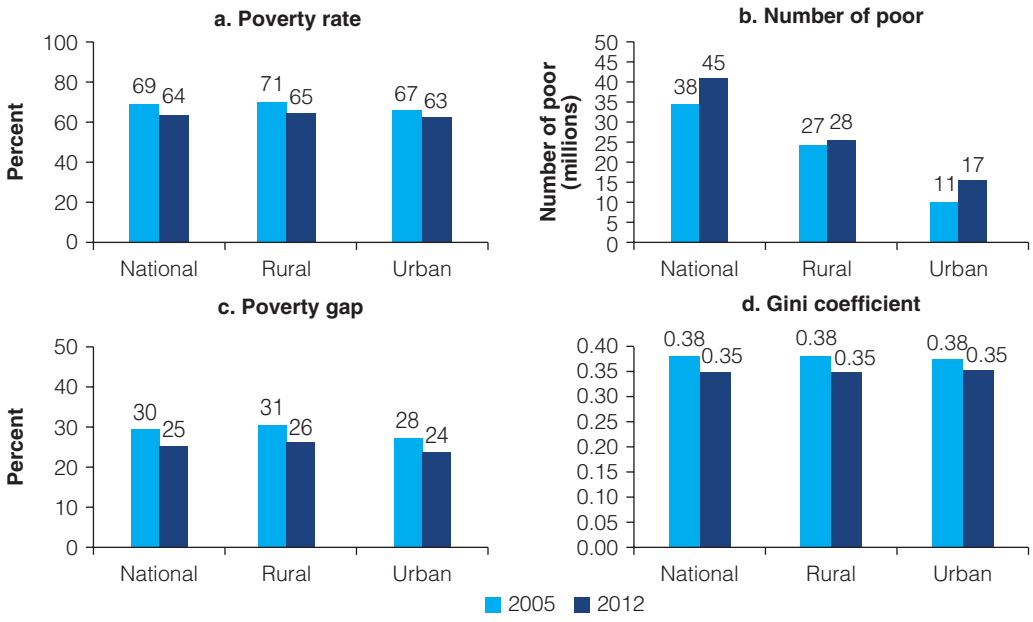
The high and pervasive poverty in the Democratic Republic of Congo manifests itself across the spectrum of human development. In spite of improvement over the past decades, the Democratic Republic of Congo continues to rank at the bottom of the United Nations (UN) Human Development Index and other indicators of multidimensional poverty (OPHI 2016). The Democratic Republic of Congo has particularly low life expectancy and high child mortality. Life expectancy in the Democratic Republic of Congo remains well below international comparison: 57.2 years for men in 2014 and 60.1 years for women (World Bank 2016c). While infant and under-five mortality declined, improvements fell short of the Democratic Republic of Congo's Millennium Development Goal and mortality rates remain high at 5.8 and 10.4 percent, respectively.

Evolution of Poverty in the Democratic Republic of Congo Since 2005: The Scope of the Challenge

Since 2005, the poverty rate has decreased slightly in the Democratic Republic of Congo, but it remains among the highest in the world. The population living below the poverty line decreased by 5.3 percent (figure 2.2) since 2005 when measured relative to the *national* poverty line and adjusting prices for regional differences. This decrease in the poverty rate was more marked in rural areas (–5.6 percent) than urban areas in general (–4.1 percent) and the capital Kinshasa in particular (–3.5 percent), where poverty decreased less, but from a lower base. Both the intensity of poverty, as measured by the poverty gap, and inequality, as measured by the Gini coefficient, have also decreased slightly (figure 2.2).[1] The share of the poor defined according to the *international* standard of individuals living below USD 1.90 per day declined from 94.3 percent in 2005 to 76.9 percent in 2012.

The relative political stability and gradual normalization of the security situation after 2002 was the primary driver of this progress. The end of active warfare in much of the country and the election of a new national government in 2006 allowed the return of millions of internally displaced people, the revival of commercial and agricultural activity and resumption of some public services (IMF 2015, 5). An attractive macro-environment with high prices for Congolese mineral exports and sharply falling inflationary pressure supported high economic growth, as well as expanding government spending, up to 2014 (IMF 2015, 38; World Bank 2009, 9).

Figure 2.2: Poverty and Inequality in Democratic Republic of Congo across Space and Time (National Poverty Line with Spatially Adjusted Price Levels)



Source: Enquête 123, 2004-5 and 2012.

A pronounced shift from low productivity subsistence agriculture toward industry and services reinforced the positive trend in poverty rates (IMF 2015b, 14).

In spite of a decrease in the poverty rate, the number of poor people in the Democratic Republic of Congo actually increased significantly to 45 million due to rapid population growth. In 2012, 7 million more Congolese lived below the poverty line than in 2005. Indeed, while the poverty rate fell in most provinces of the Democratic Republic of Congo, the number of poor increased everywhere except in Orientale and North Kivu. Although these regions remained affected by insecurity throughout the period under review, the fact that poverty did not increase could be attributed to a number of factors, including easier access to trade with and through Eastern Africa, revival of artisanal mining, the presence of large contingents of UN troops, and aid-funded nongovernmental organizations (NGOs).

The rise in the number of poor is driven by the second highest fertility rate in Africa. In 2015, the Democratic Republic of Congo had a total fertility rate of 6.6 children per woman, behind only Niger, and a population growth rate of 3.2 percent, undermining the per capita impact of the relatively fast, natural resource-driven GDP growth of 6.5 percent over the past decade. Fertility varies from 5.4 children per woman in urban areas to 7.3 in rural areas. Fertility also varies by province, from 4.2 in urban Kinshasa to 8.2 in Kasaï Occidental (map 2.1).

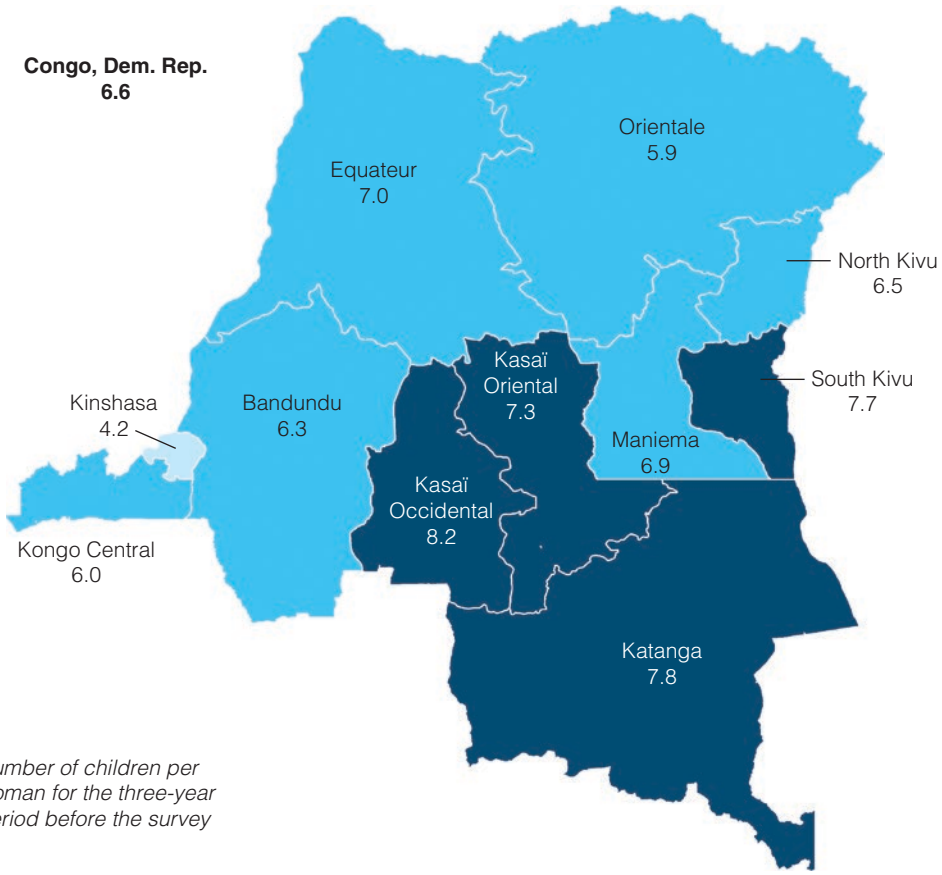
The rapidly growing population and fast-paced urbanization add pressure to weak or nonexistent infrastructure, especially in the water and sanitation sector. The population in Democratic Republic of Congo is expected to more than double by 2050 and the Democratic Republic of Congo will be one of the nine countries contributing to half of the global population growth over 2015–50 (UN 2015).[2] This growth has direct implications in terms of infrastructure and service delivery in a country that is already experiencing a large infrastructure gap and struggling to deliver basic services.[3] Urban population growth has been particularly overwhelming and largely unplanned. Over the past 20 years, the Democratic Republic of Congo's cities have

grown at 3.9 percent, almost twice the global average. The capital Kinshasa has grown at 4.4 percent in the past 20 years and will remain among the continent's three largest megacities by 2030 (UN 2014).

In the face of this rapid population growth, achieving not just a reduction in poverty rate but in the total number of poor would require an even faster economic expansion or its more effective translation into opportunities for poorer Congolese. Un- and under-employment remain key sources of poverty in the Democratic Republic of Congo, especially in urban areas, where low human capital and a business climate ranked among the worst in the world hinder the growth of businesses. While the mining sector has driven gross domestic product (GDP) growth, it has been less successful in terms of job creation and income generation. Capital intensive in nature, mining employs less than 8 percent of the Democratic Republic of Congo's labor force even if artisanal workers are counted (IMF 2015, 18, 30).

Looking toward the future, the Democratic Republic of Congo's prospects of diversifying its economy and investing in human capital through education, health, and basic services such as WASH, appear to be narrowing. Many of the key drivers of the Democratic Republic of Congo's post-civil-war growth are under threat. Residual armed conflict continues to fester in eastern Democratic Republic of Congo, and a constitutional crisis due to the delayed presidential election threatens the legitimacy of the government and broader peace. Prices for key exports of the Democratic Republic of Congo remain significantly below their levels in the early 2010s, putting pressure on the economy and government budget.

Map 2.1: Fertility Differences across Provinces



Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2013–14.

Spatial Distribution of Poverty in the Democratic Republic of Congo

Poverty is high across all former 11 provinces, none of which achieved a poverty rate below 49 percent. While no clear provincial patterns emerge, the highest poverty rates tend to occur in the forested northwest and inaccessible central Democratic Republic of Congo, in particular Bandundu, Equateur, and the Kasais. Kinshasa has a lower poverty rate and inequality than most provinces, yet its large population also leads to a high absolute number of poor and by far the highest density of poverty (table 2.1).

After the recent administrative reorganization into 26 smaller provinces, Kinshasa will be the province with the single highest absolute number of poor people: over 4 million (map 2.2). A similar combination of high numbers of poor people with comparatively low poverty rates occurs in the new Haut-Katanga province that is centered on Democratic Republic of Congo's second city Lubumbashi, the Atlantic province Kongo Central, and the densely settled Kivu provinces in the east. By contrast, the new provinces of Kwilu and Lomami (map 2.2) are examples of areas with both high poverty rates and a high number of poor. Other provinces, such as Sankuru, are extremely poor but relatively sparsely settled.

A striking characteristic of the Democratic Republic of Congo is that poverty is almost as high in urban (62.5 percent) as rural (64.9 percent) areas once differing price levels are adjusted for.[4] The fact that most poor people still live in rural areas is thus not primarily caused by relatively higher rural poverty rates, but simply due to the still predominantly rural distribution of the population in general.

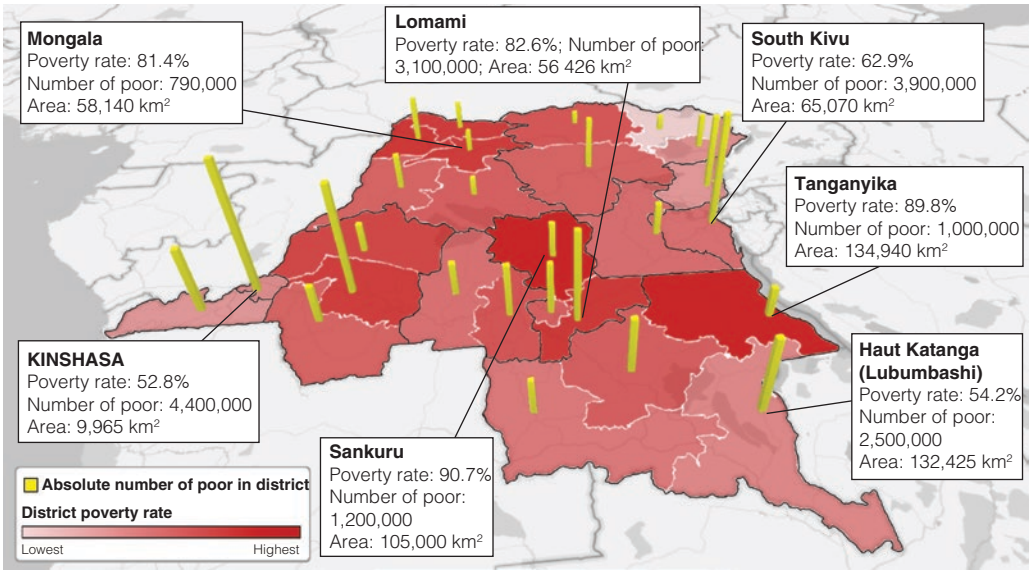
While urban poverty is nearly as high as rural deprivation overall, urban poverty rates do differ by city size as shown in figure 2.3. While the poverty rate is *comparatively* low in the capital and megacity Kinshasa (53 percent), it is higher in other major cities (63 percent), and in excess of even rural poverty in more marginal, minor cities (81 percent).[5] Even the lower poverty rate in Kinshasa still implies that more than half the capital's population live in poverty, an extraordinarily high and growing number of poor people.

Table 2.1: Poverty in the Former 11 Provinces

	2012		
	% Poor	Number of poor (m)	Poverty density (poor/km^2)
Bandundu	77	5.9	20
Equateur	76	5.3	13
Kasaï Oriental	7	4.7	27
Kasaï Occidental	75	4.2	27
Maniema	63	1.2	9
South Kivu	63	3.9	60
Katanga	63	6.5	13
Orientale	55	4.1	8
Kinshasa	53	4.4	397
Bas Congo	49	2.2	40
North Kivu	49	2.6	43
National	**64**	**45**	**19**

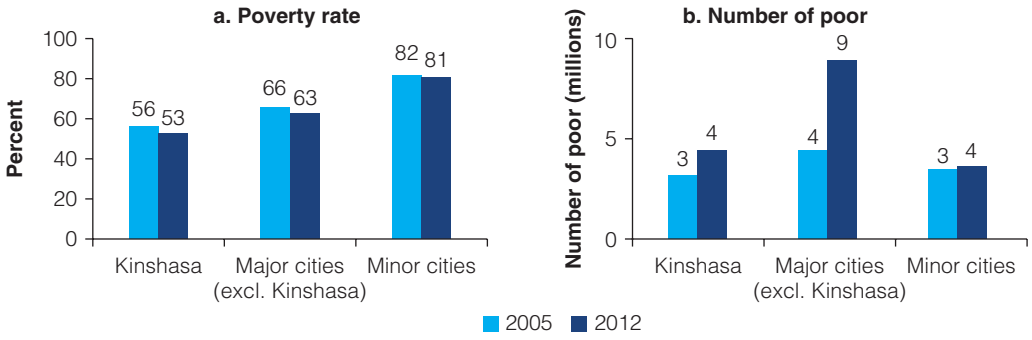
Source: Enquête 123 2012.
Note: km^2 = square kilometers. m = millions.

Map 2.2: Poverty Rate (Percent) and Absolute Number of Poor in 26 New Provinces



Source: Enquête 123, 2012.
Note: Former province boundaries in black.

Figure 2.3: Poverty in Urban Areas



Source: Enquête 123, 2004-5 and 2012.
Note: Major cities are here defined as those with "ville statutaire" status.

This is an urbanization that "cannot be characterized as economically dense, connected, and livable" but is instead "crowded, disconnected, and costly for households and firms" (World Bank 2016a, 33). The elevated urban poverty found in Congolese cities suggests these are examples of a "concentration of poverty rather than productivity" resulting from agglomeration due to a "push of rural instead of the pull of urban areas." Congolese cities, especially the more marginal ones, exhibit high and entrenched poverty because "urbanization in labor-abundant, capital-deficient areas will not generate the same economic dynamism" as in areas where "labor and capital assets are more balanced" (Bryceson 2009).

The spatial distribution of poverty in the Democratic Republic of Congo poses a central challenge for the allocation of scarce resources. As the International Monetary Fund (IMF) noted recently, in the Democratic Republic of Congo "the poorest provinces are not the prime recipient of public resources" (IMF 2015, 9). There are strong incentives and established dynamics favoring a prioritization of major urban centers, in which investments have comparatively high returns. Moreover, while poverty rates may be lower in major centers, the absolute number of poor is not only high, but densely concentrated and rapidly rising. Yet, neglecting rural areas and marginal towns risks perpetuating privation where it is most severe and, at least for now, most common. The pervasive nature of extreme poverty in the Democratic Republic of Congo confounds an easy prioritization of pro-poor interventions.

In response to this challenge of public resource allocation across space, the World Development Report 2009: *Reshaping Economic Geography* counseled a flexible mix of universal institutions, connective infrastructure, and spatially targeted measures to help countries manage an equitable transition toward a modern, connected, and productive society. In the area of basic infrastructure, such as WASH services, the report advised a "spatially blind" approach. Governments should provide basic "amenities […] to everyone, regardless of place" so that "people in the least fortunate places do not have to wait […] until their nations reach high income levels" (World Bank 2009). This recommendation is based not just on a moral argument for equity, but a conviction that universal access to basic services is the "bedrock […] of an effective integration" in which people are pulled to cities by agglomeration economies in an efficient manner, rather than pushed out of their rural homes "by the lack of schools, health services and public security" as is happening in many areas of the Democratic Republic of Congo (World Bank 2009).

These insights give the new universal access targets of the UN SDGs an economic foundation, yet in the context of the Democratic Republic of Congo WASH sector such targets will remain illusory without a better understanding of the specific service constraints and underlying institutional bottlenecks in the provision of safe water and sanitation.

Notes

1. Note that household surveys can have limitations in capturing wealthier households, resulting in a lower Gini coefficient than might be expected.
2. The UN estimate that during 2015–50, half of the world's population growth is to be concentrated in nine countries: India, Nigeria, Pakistan, Democratic Republic of Congo, Ethiopia, Tanzania, the United States, Indonesia, and Uganda, listed by the size of their contribution.
3. For instance, Democratic Republic of Congo ranked 159th out of 160 countries against the Logistics Performance Index in 2014 with only Somalia faring worse. Similarly, Democratic Republic of Congo's electricity access rate (9 percent) is far below Sub-Saharan Africa's average rate of 31 percent and there are significant disparities between urban and rural areas, where access rates reach just 1 percent. The current level of investments in cities is far below the amounts required to address the problems. A 2010 World Bank study of the urban sector estimated investment needs in urban areas at 16–17 percent of central government expenditures, or USD 12 per capita, three times the actual investment level.
4. Using the national poverty line and Enquête 12–3 (2012) data and adjusting for different price levels in different urban and rural areas.
5. "Major cities" refer to "ville statutaire," which aside from Kinshasa, include the following: Boma, Matadi, Bandundu, Kikwit, Mbandaka, Zongo, Gbadolite, Kisangani, Beni, Butembo, Goma, Bukavu, Kindu, Kolwezi, Lubumbashi, Likasi, Mbuji Mayi, Mwene Ditu, Kananga, Tshikapa. Note that some individual cities (such as Lubumbashi) appear to have lower poverty rates than Kinshasa.

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Chapter 3
Level and Quality of Water and Sanitation Access for the Poor

Key Points

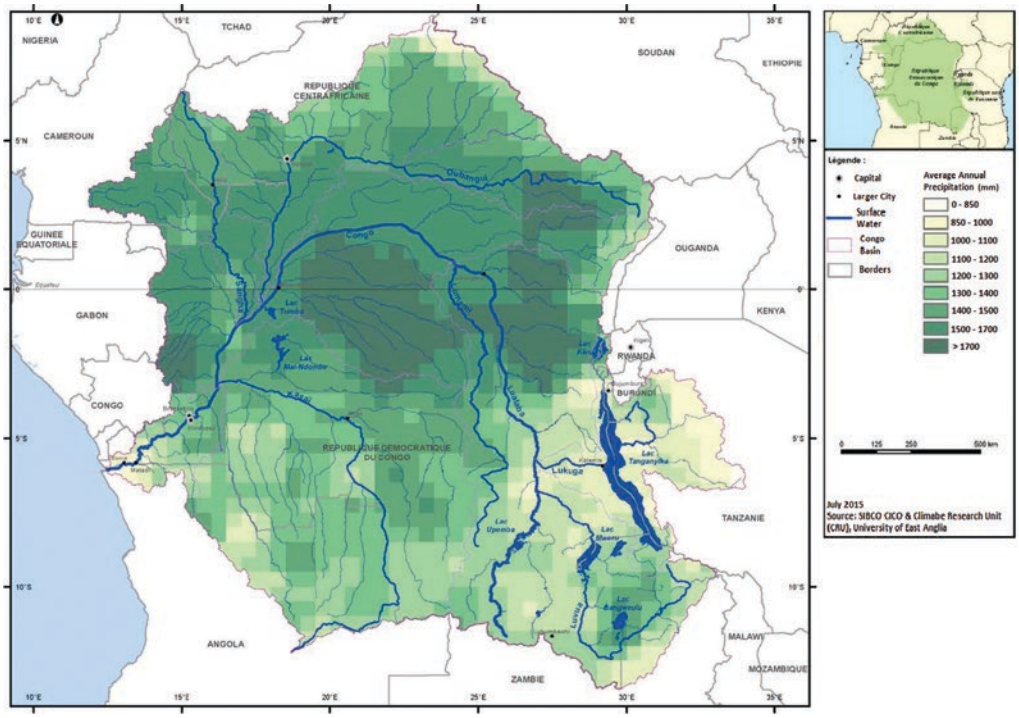
- Access to improved water, sanitation, and hygiene (WASH) services is low in the Democratic Republic of Congo. Improved water facilities are available to 52 percent of the Democratic Republic of Congo's population, while less than 29 percent have access to improved sanitation.
- Rapid population growth has caused a large increase in the total number of Congolese lacking access to improved WASH services.
- Access to improved water is much higher in urban (81 percent) than in rural areas (31 percent), but lower than it was in the 1990s, and wide access variations exist between major and marginal urban areas. The urban–rural gap is more compressed in sanitation due to low overall access.
- In a context of pervasive service shortfalls, the poor in the Democratic Republic of Congo have significantly less access to improved water and sanitation. Among the almost two-thirds of Congolese living below the national poverty line, access to improved water and sanitation is almost 10 percent lower than among the non-poor, respectively.
- The poor in larger urban agglomerations tend to have better WASH services but the challenges in urban areas—and particularly secondary urban agglomerations—are growing with urbanization.
- Water quality is a major problem across urban and rural zones, and water source types. Surveys conducted by the Democratic Republic of Congo WASH Poverty Diagnostic (WPD) tested water quality at point of use for fecal matter contamination. The results show that contamination is shockingly common, even among households with access to piped water in major urban areas, with near universal contamination in the rural areas surveyed.
- The overall picture is thus one of particularly dramatic WASH service shortfalls among the poorest and rural dwellers, but a pervasive lack of truly safe services even among wealthier and urban households.
- The 2015 Millennium Development Goals (MDGs) for WASH were missed by a wide margin. Given current trends and allocations, the even more demanding 2030 SDGs seem out of reach. The SDGs can nonetheless serve to inform policies and set priorities, particularly with respect to water quality.

The Democratic Republic of Congo's Hydrological Resources: Water Rich but Service Poor

The Democratic Republic of Congo is defined by water, from the Congo basin that shapes its territory and gives it its name, to the important rainfall this tropical country receives. The Democratic Republic of Congo is extraordinarily blessed with water resources, possessing over 50 percent of Africa's surface water reserves and almost a quarter of the continent's internal renewable water resources (UNEP 2011). With annual average rainfall in excess of 1,500 millimeters (map 3.1), the Democratic Republic of Congo benefits from 10 times the precipitation of countries such as Niger, and 50 percent more than neighbors such as Tanzania and Zambia (World Bank 2016). The *daily* volume of water the Congo River discharges into the Atlantic could supply all Congolese with sufficient water for seven years.[1]

In spite of plentiful hydro-resources, access to *safe* drinking WASH remains low in the Democratic Republic of Congo, both in absolute terms and relative to regional averages.[2] Moreover, the past decades have seen few improvements, and in some aspects, even declines in WASH services. The poor have even less access to improved WASH services than the population in general, and this access inequality is reinforced by profound differences in services between the comparatively well supplied capital Kinshasa, disadvantaged secondary cities, and rural areas that lag even further behind.

Map 3.1: Average Annual Precipitation across the Democratic Republic of Congo



Source: SIBCO (Climate Research Unit, University of East Anglia) 2015.

The Evolution of WASH Services: Modest Access Improvements Overpowered by Population Growth

Low Access to Improved WASH

Improved water facilities are available to 52 percent of the Democratic Republic of Congo's population, less than 29 percent have access to improved sanitation and only 3 percent of households have handwashing facilities with soap (UNICEF and WHO 2015). Thus, even though improved water access is low, use of improved sanitation facilities is dramatically lower still. These access rates are substantially below the Sub-Saharan averages, and even compared to its nine direct neighbors,[3] the Democratic Republic of Congo suffers from second lowest rate of improved water access and fourth lowest rate of sanitation access as map 3.2 illustrates (UNICEF and WHO 2015).

Stagnating Service Expansion Failing a Growing Population

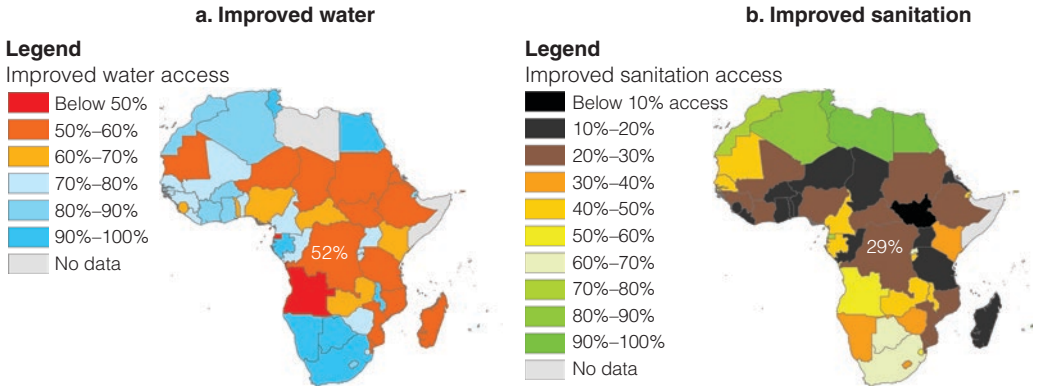
Democratic Republic of Congo has made only "limited or no progress" and missed the 2015 MDG of halving the population proportion without access to improved drinking water and basic sanitation. Access of the Democratic Republic of Congo's population to both improved water and sanitation has risen by barely 3 percent since the first democratic elections in 2006, as outlined in figure 3.1.

Moreover, rapid population growth has caused an increase in the total number of Congolese lacking access to safe water and sanitation facilities by more than a quarter since 2005 to over 35 million and 53 million, respectively (World Bank 2016). As with poverty levels, minor advances in the *percentage* of access have been overwhelmed by population growth, leading to an increasing number of Congolese without safe water and sanitation facilities.

Urban Versus Rural Access

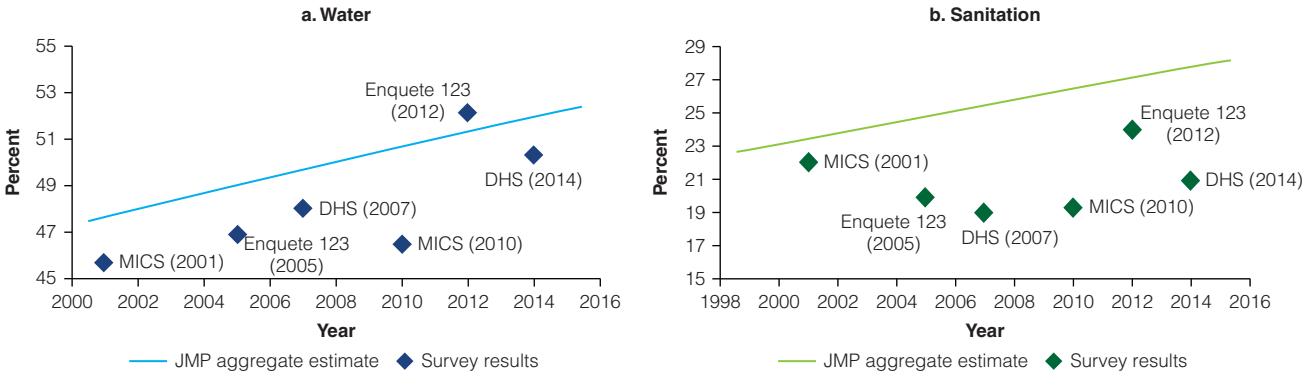
Access to improved water sources is much higher in urban areas than in rural zones: 81 percent access in the former compared with only 31 percent in the latter (UNICEF and WHO 2015). This urban–rural gap is one of the fundamental characteristics of improved

Map 3.2: Access to Improved Water and Sanitation in 2015 of the Democratic Republic of Congo in the African Context



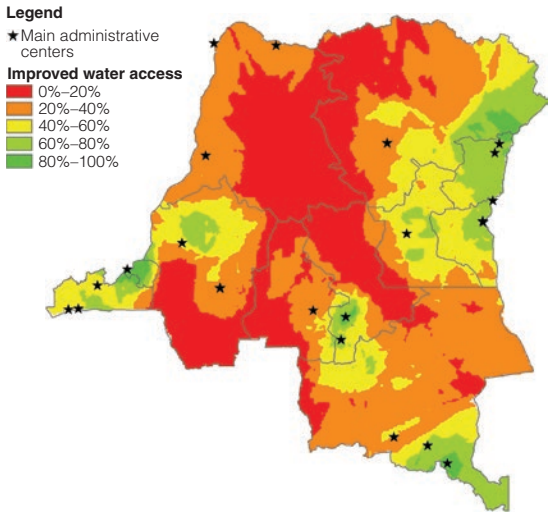
Source: UNICEF and WHO 2015.

Figure 3.1: JMP Estimates of Access to Improved Water and Sanitation vs. National Survey Results



Source: Joint Monitoring Program (JMP), UNICEF and WHO 2015; World Bank calculations.
Note: DHS-EDS 2014. The reason for the apparent JMP overestimate of national-level access (that is, the trend line appears above most individual estimates) is that JMP does not take the national survey results directly from the surveys; instead, it takes the rural and urban results separately, and then re-aggregates these to a national value using the United Nations Development Programme (UNDP) population estimates, thus obtaining a national-level access estimate different from the one in the original survey itself. For detailed JMP estimates, see appendix E. DHS = Demographic and Health Survey. MICS = multi-indicator cluster survey. The reason for the apparent JMP overestimate of national-level access (that is, the trend line appears above most individual estimates) is that JMP does not take the national survey results directly from the surveys; instead, it takes the rural and urban results separately, and then re-aggregates these to a national value using the United Nations Development Programme (UNDP) population estimates, thus obtaining a national-level access estimate different from the one in the original survey itself.

Map 3.3: Access to Improved Water and Main Administrative Centers (Provincial Capitals and Statutory Cities)



Source: Kriging based on Demographic and Health Survey 2014.

water supply in the Democratic Republic of Congo, and reaching universal access targets under the SDGs will not be possible without improving supply not just in the rapidly growing cities, but the vast, remote rural hinterlands (map 3.3). In light of continued population growth, an expected 38 million rural dwellers will require access to reach universal improved water supply by 2030.[4]

The access rate to improved water in cities remains lower than it was in the 1990s, though has recovered from its nadir at the end of the most intense phase of civil conflict in the mid–2000s.[5] Rural access had also declined during the conflict years, but recovered faster and now surpasses access rates of the 1990s.

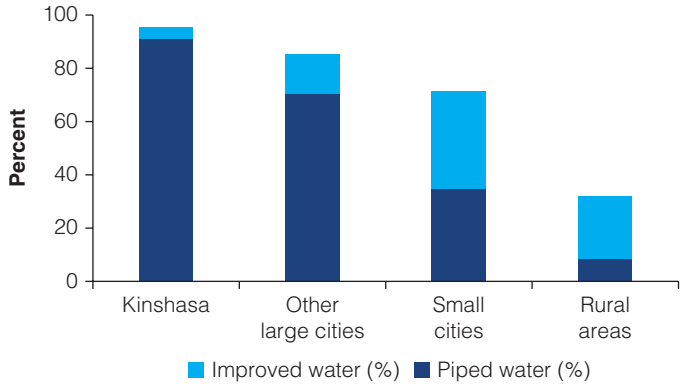
While access to improved water is overall much better in urban than rural areas, smaller towns are doing worse than larger cities. The capital and megacity Kinshasa has higher access to improved water in general, and piped water specifically, than other large cities (above 300,000 inhabitants), and smaller towns lag still further behind (figure 3.2). In fact, Kinshasa's performance is on par with that of other African capitals, but there is a significantly wider gap with other urban areas than in comparable countries (appendix B). The rapid growth of the urban population has also meant that in spite of a recent access rate improvement, the number of urban dwellers without improved access has increased by half a million in just the past eight years.[6] To reach universal improved access by 2030, and taking into account expected urban population growth, an expected 26 million additional urban dwellers will require coverage.

In the sanitation sector, access is lower overall and differences between urban and rural areas more compressed than in the water sector (figure 3.3). The long-term aggregate trend indicates nearly equivalent access rates of approximately 28.5 percent in urban and 28.7 percent in rural areas, with a slightly negative urban trend and strongly positive rural access improvements over the past decade (UNICEF and WHO 2015). The latest available nationally representative survey qualifies the Joint Monitoring Program (JMP) aggregate estimates, showing urban access still approximately 6 percent higher than rural access, though also reflecting a faster access increase in rural areas (2007 and 2014 DHS). Virtually all facilities are on-site as there are practically no functional sewer networks. Open defecation is significantly more common in rural areas, though remains below 20 percent even there. Differences between cities are less pronounced in sanitation than water access, though unimproved facilities appear to be more common in smaller towns.

Provincial Outliers

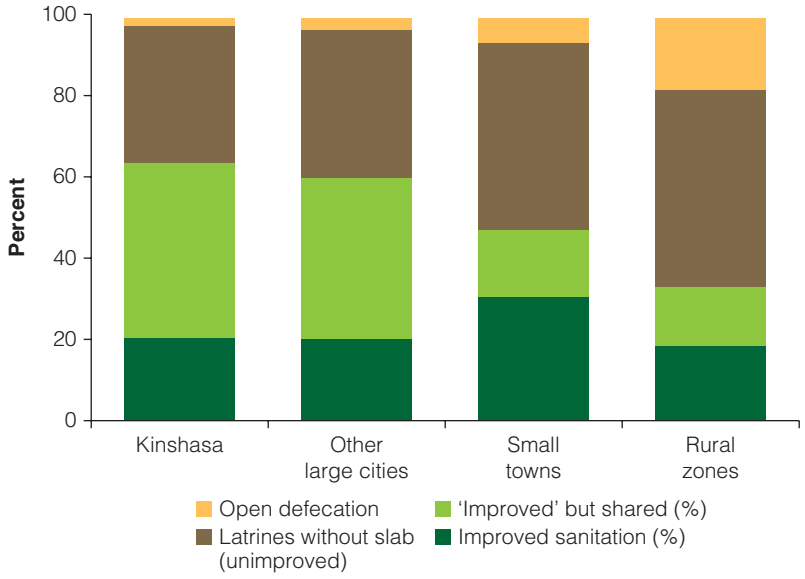
There are important disparities across provinces, most marked in the case of water access. In the eastern mountainous areas, such as North and South Kivu, water of relatively good quality is typically sourced from protected springs either directly (25.2 percent) or through

Figure 3.2: Access to Improved Water and Piped Water for Urban–Rural Spectrum



Source: Demographic and Health Survey 2014.

Figure 3.3: Access to Improved and Unimproved Sanitation for Urban–Rural Spectrum



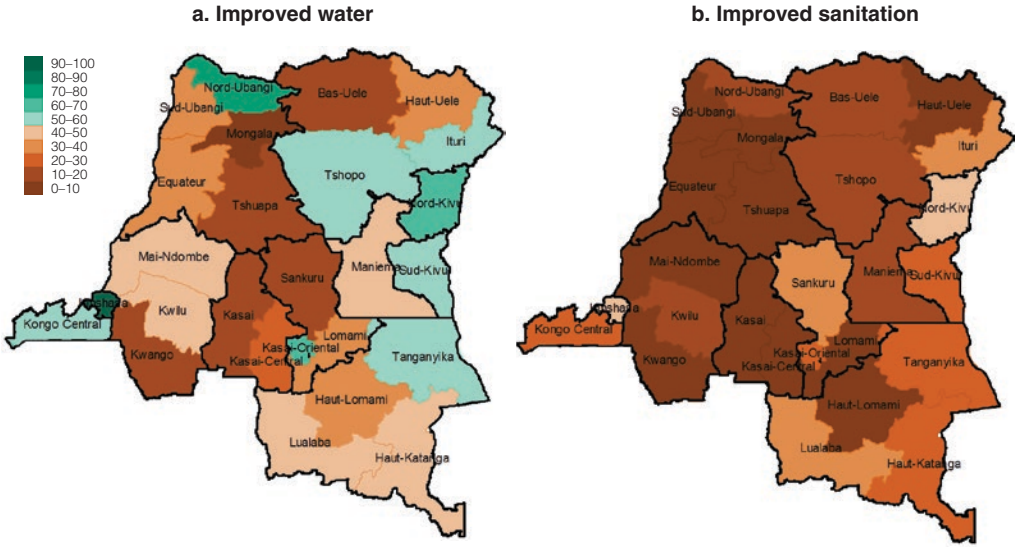
Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2014.

local small networks with reservoirs and standpipes, contributing to very high piped access (47.7 percent). These provinces also have comparatively high supply of improved water for the poor (map 3.4). In the flatter, drier southern provinces, such as Katanga and Bandundu, water is typically taken from unprotected surface water (53.9 percent) or unprotected wells (8 percent) at significantly longer distances than in the rest of the Democratic Republic of Congo, with associated quality and gender issues. In the central forest areas, such as Equateur and Orientale, water is abundant with widespread use of unprotected surface water (59.8 percent) and protected springs (18 percent), but there are few improved sources overall (less than 33 percent) and thus widespread quality issues.[7] Access to improved sanitation for the poor is universally low across provinces and districts, with particularly low values in the rural, forested areas of the northwest and central Democratic Republic of Congo.

A number of geographic, climatic and historical factors explain the relatively better access to improved water in the eastern parts of the Democratic Republic of Congo. Historically, the eastern provinces have been a focus for water interventions since the late colonial period. The Belgian Indigenous Welfare Fund (*Fonds du Bien-être Indigène*, FBEI), set up in 1947, prioritized improving rural water supplies in the Rwanda-Burundi and Kivu-Maniema areas early on (Borgniez 1952, 4, 18; de Raeve 1997, 331). In peri-urban and urban areas, the national utility REGIDESO (Service National d'Hydraulique Rurale (National Rural Water Service) also engaged early prior to decolonialization (de Raeve 1997, 328).

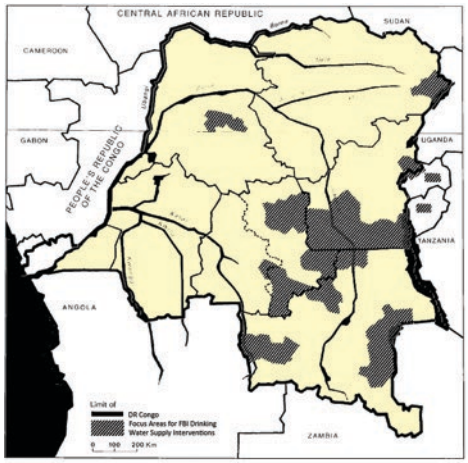
Following the demise of colonial institutions, the eastern region remained an area of active interventions in water supply, supported by local civil society organizations such as the Comité Anti-Bwaki, founded in the 1960s to fight malnutrition, the Institute Social Africaine supported by the Diocese of Bukavu in South Kivu, and, from the mid–1970s, the UNICEF Rural Water Program, which had its first operational base in North Kivu and later became the National Rural Water Service (SNHR). The region has also been a focal area of humanitarian interventions in the Democratic Republic of Congo over the past 20 years following the massive influx of refugees from Rwanda in 1994 and subsequent civil conflict in the region.

Map 3.4: Access to Improved Water and Sanitation for the Population below the Poverty Line, 2012



Source: Enquête 123, 2012.
Note: The map represents the 26 new provinces; the borders of the 11 former provinces are underlined.

Map 3.5: The Colonial Indigenous Welfare Fund's Water Interventions, 1948–63



Source: de Raeve 1997.

Geographically, the eastern provinces are marked by mountainous terrain providing many opportunities for cost-effective gravity-powered piped water systems. Of 452 functional autonomous systems in the Democratic Republic of Congo, almost 60 percent were situated in the provinces of South Kivu, North Kivu, and Maniema (Tsitsikalis 2014). The eastern provinces close to the border with Rwanda, Uganda, Burundi, and Tanzania, are also more accessible than central and northwestern Democratic Republic of Congo, facilitating construction and spare-part supplies.

This particular confluence of factors behind relatively better water supply in eastern Democratic Republic of Congo may be difficult to replicate in more remote or water-scarce areas of the country, though some lessons appear transferable, such as the importance of local community involvement combined with long-term interventions by aid-funded nongovernmental organizations (NGOs) and the acceptance of the need to pay, which is critical for systems requiring treatment or pumping.

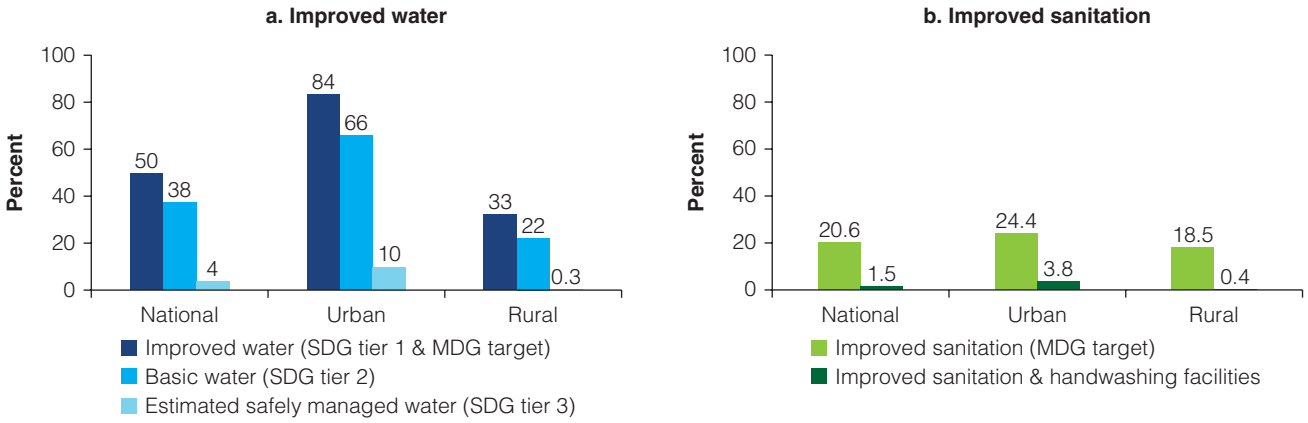
The New Sustainable Development Goals: Access Plus and the Water Quality Problem

More Ambitious New Sector Targets

Whereas the MDGs aimed to half the population without improved access by 2015, the new United Nations (UN) SDGs for 2030 set more complex and ambitious targets. In the new framework, technically "improved" water sources, such as covered wells or standpipes, which were the final target under the MDG framework, are merely the lowest of three tiers of water access. The second tier, "basic water," requires the water source to not only be technically improved, but also be within 30 minutes of the household. The highest tier, "safely managed water," refers to water sources that are not only technically improved, but on premises, readily available, and free of contamination. For sanitation, the new SDG Target Tier also goes beyond the prior MDG aim of non-shared improved facilities and in addition requires a handwashing facility with water and cleansing agent, as well as safe disposal of fecal matter. The SDG target is for universal access to the highest tiers of water and sanitation by 2030.

The Democratic Republic of Congo missed the 2015 MDG targets, and access to even the lowest tier of improved water stands at barely half the population for water sources, and less than a third for sanitation facilities (map 3.2, figure 3.1). The situation is even more dramatic for the higher access tiers targeted by the SDGs. Figure 3.4 illustrates the difference between current levels of improved access to water and sanitation, basic water, and estimated safely managed water access, as well as comparing sanitation tiers. The relevant definitions are provided in box 3.1. In the sanitation sector, handwashing facilities, which are a critical part of

Figure 3.4: Current Improved Access to Water and Sanitation Compared with SDG Water and Sanitation Access Tiers



Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2014.
Note: MDG = Millennial Development Goal. SDG = Sustainable Development Goal.

Box 3.1: Summary of Access Definitions

Improved Water (SDG Tier 1 and MDG Target)
A source that, by nature of its construction or through active intervention, is protected from outside contamination, in particular from contamination with fecal matter. Includes any piped water into dwelling or yard, standpipes, boreholes, protected (covered) wells, protected springs, and rainwater

Basic Water (SDG Tier 2)
Improved (see above) and within 30 minutes of household

Safely Managed Water (SDG Target Tier 3)
Improved (see above), on household premises, water quality free of contamination and continuously available

Improved Sanitation (SDG Tier 1 and MDG Target)
A facility that hygienically separates human excreta from human contact. Includes flush toilets (as long as not flushing into the nearby environment), piped sewer access, septic tanks, pit latrines with slab, and composting toilets

Safely Managed Sanitation (SDG Target Tier)
Improved (see above) with handwashing facilities with water and soap and linked to safe service chain/disposal

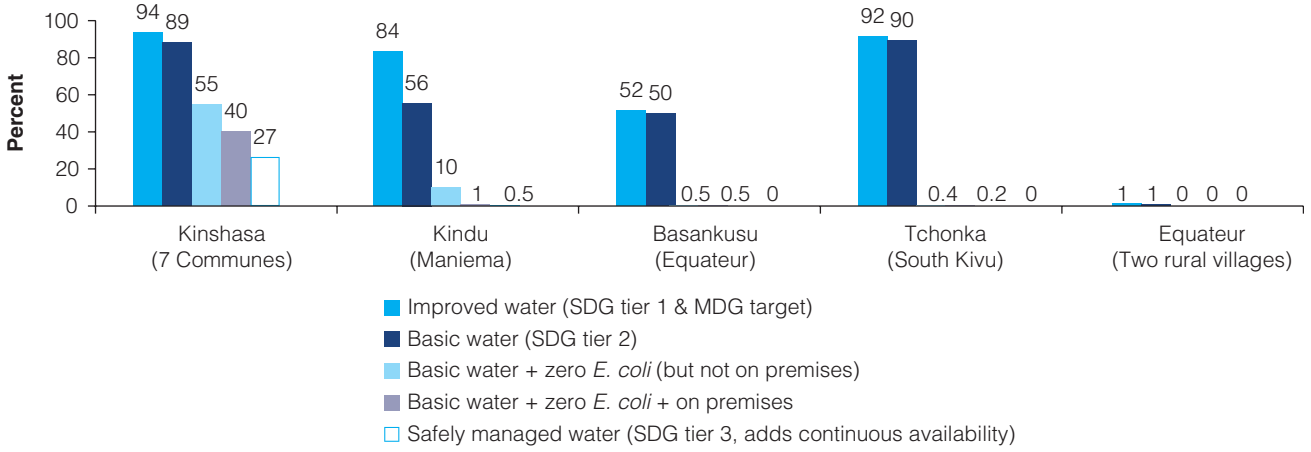
the SDG target indicator, are extremely rare. Fewer than 2 percent of households nationally have improved toilets and handwashing facilities. As there are presently no systematic services to safely dispose fecal matter in the Democratic Republic of Congo, the sanitation SDG target indicator is lower still. In other words, over 98 percent of households currently do not meet the SDG sanitation target. Basic water access is also significantly lower than improved access. For the highest SDG tier of safely managed water, even optimistic upper-bound estimates show very low current levels, barely 4 percent nationally (figure 3.4, with definitions in box 3.1).[8]

The Democratic Republic of Congo WPD carried out representative field surveys, including water quality testing, in selected locations, providing an additional snapshot of access to the SDG target of safely managed water across a spectrum of specific urban and rural settlements (see appendix C for details on the survey design and methodology). Figure 3.5 gives the details of individual site results. Even in Kinshasa, safely managed water access barely reaches 27 percent, and is virtually unheard of in other cities, towns, and rural hamlets. This underlines just how ambitious the SDG targets are in the Democratic Republic of Congo.

Water Quality: A Universal Problem in the Democratic Republic of Congo

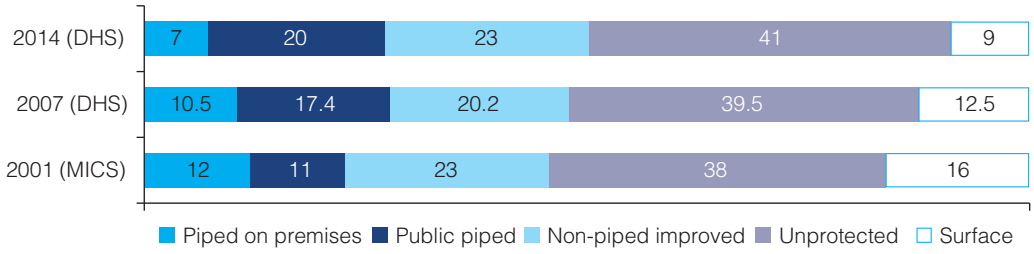
Water supply infrastructure differs greatly between urban and rural study sites, but one issue cuts across and is a critical obstacle to safely managed access in the Democratic Republic of Congo: water quality. Across field study sites, very different water supply infrastructure was observed.

Figure 3.5: Improved, Basic, and Safely Managed Water Access (and Intermediate Steps) across the Urban–Rural Spectrum



Source: Survey carried out by World Bank WASH Poverty Diagnostic.
Note: MDG = Millennial Development Goal. SDG = Sustainable Development Goal.

Figure 3.6: Access to Water, by Service Type



Source: National Survey Results from 2001, 2007, and 2014.
Note: DHS = Demographic and Health Survey. MICS = multi-indicator cluster survey. Percentages of individual surveys differ from Joint Monitoring Program (JMP) figures (UNICEF and WHO 2015), which are computed as a trendline estimate averaging multiple surveys.

While in remote rural hamlets in Equateur even improved sources, such as covered wells and protected springs, are lacking, some larger rural settlements, such as Tchonka in South Kivu, boast piped schemes and thus high improved and basic water access (figure 3.5). More typical are small towns, such as Basankusu in Equateur, and regional centers, such as Kindu, the capital of Maniema province, where substantial proportions of the population have access to improved sources, generally through a mix of covered wells, protected springs, and standposts from small piped schemes. Kinshasa stands out with its dense and widespread piped supply. In all cases, however, water quality is a major concern and key contributor to low safely managed access (figure 3.6).

The WPD surveys tested water quality at point of use for *E. coli* bacteria, an indicator for fecal matter contamination, which can lead to "severe and sometimes life-threatening disease"[9] (WHO 2011, 124). The World Health Organization (WHO) set an objective of zero *E. coli* per 100 milliliters of water as "the goal for all water supplies," which "should be the target even in emergencies" (WHO 2008, 107).

Point-of-use contamination with *E. coli* is shockingly common and cuts across location and supply technology (table 3.1). Even among households with access to piped water in the

Table 3.1: Contamination with *E. coli* at Point of Use
Percentage of samples with MPN > 0/100 ml

	Kinshasa[a]	Kindu	Basankusu (Equateur)	Tchonka (South Kivu)	Rural Hamlets (Equateur)	Rural South Kivu[b]	Rural North Kivu
Improved Water Source	40%	84%	99.1%	99.6%	100%	79%	64%
Piped Water Source	36%	82%	-	99.6%	-	78%	64%
Other Improved Sources	71%	85%	99.1%	100%	100%	84%	67%
Unimproved Source	53%	84%	95%	99.6%	98.3%	85%	84%

Source: World Bank calculation using Congo, Dem. Rep., WPD and MDA surveys 2016.
Note: MDA = mass drug administration. MPN = most probable number. WPD = Water, Sanitation, and Hygiene Poverty Diagnostic.
[a] Data from Kinshasa is representative for seven communes: Ndjili, Makala, Kinshasa, Mont Ngafula, Kimbanseke, Kisenso, Kasa-Vubu.
[b] Data for Rural South and North Kivu was collected in cooperation with *zones* the World Bank Global Practice for Health, Nutrition and Population in a survey of 13 rural health zones (seven in South Kivu, and six in North Kivu with a total sample size of 650 households.

relatively well-served capital Kinshasa, more than a third of water samples were contaminated. More than half of water samples drawn from *non*-piped sources in Kinshasa were contaminated. In the city of Kindu, small hamlets in rural Equateur, and a cross-section of rural areas in South and North Kivu, *E. coli* contamination was even higher. While piped water sources tend to perform better, the problem of highly prevalent fecal contamination clearly cuts across location and technology. Even technologies that are commonly regarded as high quality, such as piped water, may not achieve positive health impacts if the water distributed is not properly treated, or if unhygienic storage and handling lead to recontamination prior to consumption.

A high prevalence of point-of-use drinking water contamination is facilitated by very low levels of household treatment prior to consumption in the Democratic Republic of Congo. According to the latest DHS (2014), less than 2 percent of household with access to unimproved water sources treat their water in any way. For households relying on improved access, less than 7 percent treat their water.

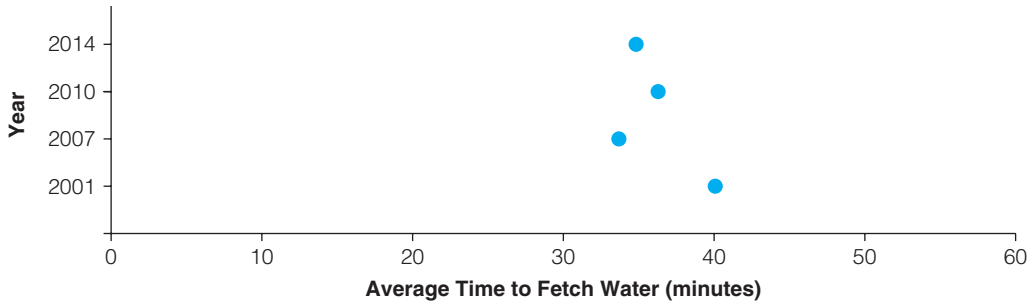
The water quality and treatment data illustrates how unsafe even improved sources generally are in the Democratic Republic of Congo. As chapter 4 details, fecal contamination of water supply constitutes a major public health threat.

Beyond Water Quality: Static or Deteriorating Service Quality

While water quality is a priority concern both in terms of SDG targets and actual health impact, other measures of "access plus" also suggest static or deteriorating quality of access. Private water connections have become relatively rarer: in effect a downshift in quality of access that goes counter to the safely managed SDG target with its on-premises goal (figure 3.6). In fact, the slight increase in the overall access rate to improved sources seems to be driven by public piped sources, such as standposts and neighbors' piped connections, partly at the expense of private connections. On a more positive note, surface-water sources, such as lakes, rivers, ponds, and canals, seem to have been gradually displaced by improved facilities.

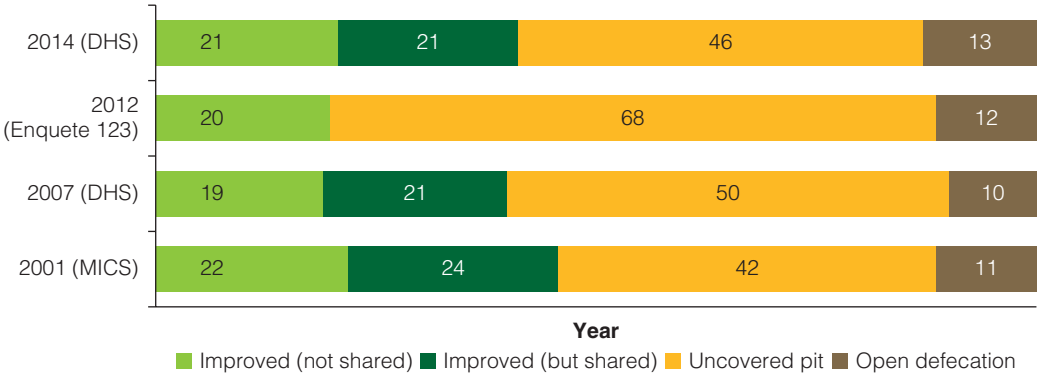
The time to water source, which is a critical part of the new SDG access definitions, has remained near constant at approximately 35 minutes after dropping slightly from 2001 to 2007 (figure 3.7). In a comparison with 25 countries in Sub-Saharan Africa, this is the seventh longest average fetch time, in spite of the relatively favorable hydrological conditions (Pickering and Davis 2012). To reach basic water targets of sources within 30 minutes fetch time, improving this parameter will be important.

Figure 3.7: "Access Plus": Time to Access Water



Source: National survey results: MICS 2001, DHS-EDS 2007, MICS 2010, DHS-EDS 2014.

Figure 3.8: Access to Sanitation, by Service Type



Source: National Survey Results from 2001, 2007, 2012, and 2014.
Note: DHS = Demographic and Health Survey. MICS = multi-indicator cluster survey.

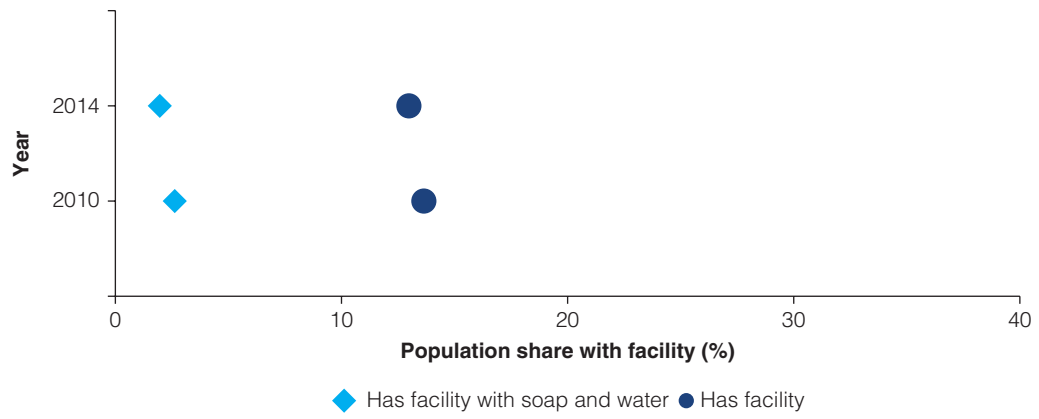
Access and trends in the type of sanitation facilities are concerning, in particular with respect to open defecation, handwashing, and the lack of a functional service chain for the safe disposal of fecal matter. Not only does unimproved sanitation continue to be widespread, but the percentage of Congolese practicing unhygienic open defecation appears to have increased over the past decade, rising from around 10–11 percent in 2001–07 to 12–13 percent in 2012–15 (figure 3.8), though this remains moderate in regional comparison.

The reversal in open defecation trends has not yet been reflected in the JMP trend estimates, and occurred despite a decade-long effort to reduce the practice through the Ecoles et Villages Assainis ([EVA] Healthy Schools and Villages) program.

Handwashing with soap is also low—the fourth lowest among 29 African countries listed in the most recent 2015 JMP report—and has declined in recent years (figure 3.9), though data from the early 2000s is lacking.

A further grave sanitation-related problem in the Democratic Republic of Congo is the widespread lack of a functional service chain for the safe disposal of fecal matter. There is no piped sewerage of scale, even in the largest cities of the Democratic Republic of Congo, and also no wastewater treatment. For the predominant on-site solutions, professional emptying and

Figure 3.9: "Access Plus": Handwashing Facilities in Households



Source: National survey results: MICS 2010, DHS-EDS 2014.

transport of accumulated fecal matter remains rare, and no safe public disposal or treatment sites exist. In other words, even improved latrines that safely contain fecal matter in the short term generally cannot be considered safe from a public health perspective, because accumulated fecal matter ultimately overflows or is emptied and unsafely dumped in unregulated disposal sites.

Thus, not only is a limited increase in improved WASH access rates over the past decade being overpowered by population growth, but quality of access is at best static and by some measures deteriorating. Water quality, time to water source, on-premises access, handwashing with soap, open defecation, and safe disposal service chains for fecal matter constitute huge challenges far beyond the past MDG targets of improved access. Moving toward the more ambitious SDG targets will require enormous new efforts.

WASH Access and Poverty

Low Access for the Poor and Pervasive Service Shortfalls

In a context of pervasive service shortfalls, the poor in the Democratic Republic of Congo have significantly less access to improved water and sanitation. Among the almost two-thirds of Congolese living below the national poverty line, access to improved water is only 48.9 percent, and improved sanitation facilities are available to only 16.6 percent; both values are approximately 9 percent below the access of the non-poor. As illustrated in table 3.2, access increases with household expenditure level, and higher-quality services are also more common among better off households. For instance, piped water on premises is three times more likely among the top 60 percent (T60) than it is among the bottom 40 percent (B40) of households by expenditure level.

Notably, however, more than a quarter of the top 1 percent of households by expenditure level use unimproved water sources, and a majority use unimproved sanitation. This indicates that even among the better off, factors such as infrastructure constraints and cultural norms limit access to improved facilities. In other words, unsafe, low-quality access to water and sanitation services affects the poor more, but it is not a condition that is limited to the poorer sections of Congolese society. Instead, use of unimproved WASH services is pervasive across almost all expenditure groups in the Democratic Republic of Congo.

Table 3.2: Access to Improved Water and Sanitation, by Household Expenditure Level

Household expenditure level	Improved water	Piped on premises	Improved sanitation	Open defecation
Below poverty line	48.9%	9%	16.6%	12%
Above poverty line	57.8%	21%	25.9%	11%
Bottom 40%	46.0%	6.5%	14.9%	12.8%
Top 60%	56.2%	17.9%	23.4%	11%
Top 10%	63.3%	26.4%	30.4%	11%
National	**52.1%**	**13.3%**	**20.0%**	**11.7%**

Source: Enquête 123 2012.

Table 3.3: Access to Improved Water and Sanitation Facilities, by Asset Wealth

Asset wealth level	Improved water	Piped on premises	Improved sanitation	Open defecation
Bottom 40%	22.3%	0.01%	16.8%	22.4%
Top 60%	68.9%	12.1%	23.1%	6.6%
Top 10%	96.6%	58.3%	34.2%	0.2%
National	**50.3%**	**7.3%**	**20.6%**	**12.9%**

Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2013–14.

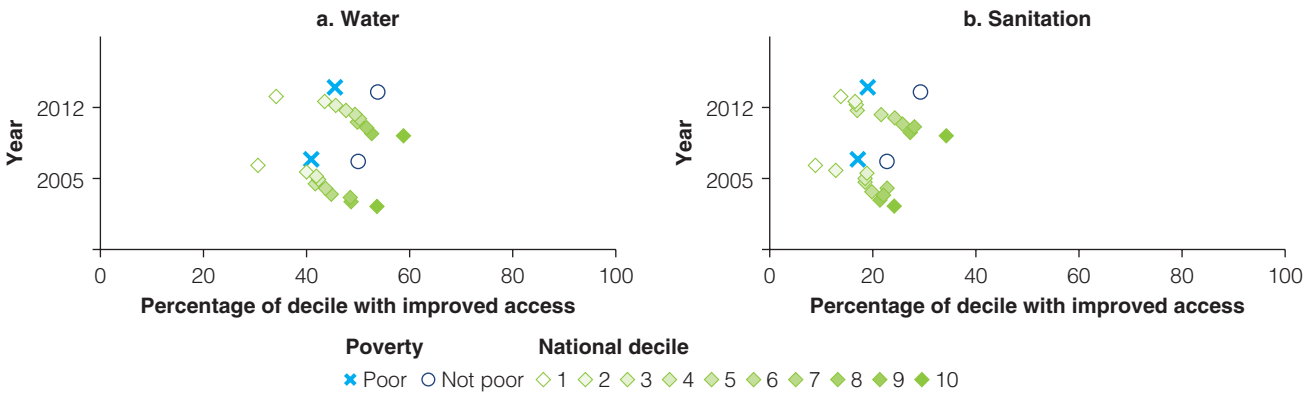
Viewed from the perspective of asset wealth, an even more stratified picture emerges.[10] As table 3.3 highlights, access to improved water is more than 40 percent higher among the T60 than the B40. The top 10 percent by asset wealth have an access rate to improved water in excess of 95 percent.

While access to improved sanitation is also more stratified when categorizing households by asset wealth rather than expenditure level, overall access remains lower and more compressed compared to water. Even among the top 10 percent by asset wealth, over 30 percent do not have improved (non-shared) toilets, again highlighting how pervasive sub-standard access to safe water and sanitation is in the Democratic Republic of Congo.

To the extent that "access plus" indicators are available in existing data, these reinforce the evidence that the B40 have worse access to services. For example, less than 10 percent of the B40 have handwashing facilities, while twice as many of the T60 do. Less than 1 percent of the B40 treat water before use, while 6 percent of the top 60 do so. More than two-fifths of the B40 travel over 30 minutes for water compared to only one-third of the T60. At the national level, the inequality in improved access by expenditure level has persisted since 2005. In sanitation, access inequality even increased as the highest deciles pulled away from the rest (figure 3.10).

The overall picture is thus one of particularly dramatic WASH service shortfalls among the poorest, but a pervasive lack of improved services even among higher expenditure and asset-rich households. Access to safe sanitation, in particular, is at dramatically low levels even among the richest top 10 percent of households. In the context of pervasive shortfalls, households below the poverty line are doing worse still. The B40 are significantly less likely to

Figure 3.10: Access to Improved Water and Sanitation, by Decile, 2005–12



Source: Enquête 123 2005 and 2012.

use improved WASH services, and less likely to use higher quality services, and this inequality has not improved since 2005, indeed, in sanitation it appears to have worsened.

Better Services for Urban Poor

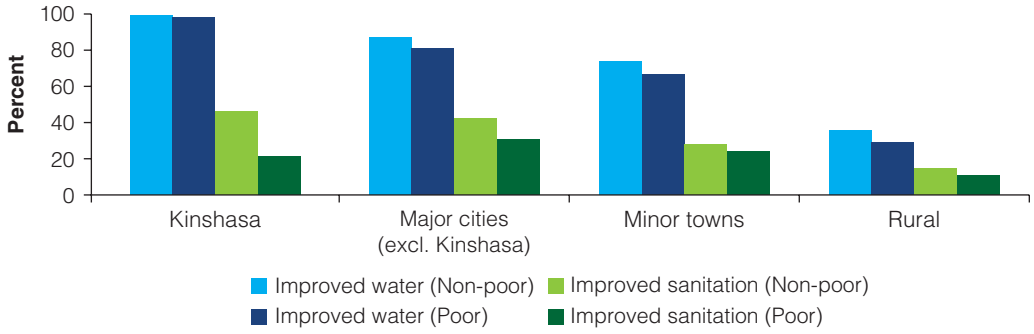
The poor in larger urban agglomerations tend to have better WASH services. Inhabitants of larger cities tend to have better access to improved services than small-town and rural households at the same level of income. As figure 3.11 illustrates, near universal access to safe water in Kinshasa means households *below* the poverty line in the capital have higher access to improved water than households *above* the poverty line in other urban areas. In turn, *poor* households in urban areas have more access than *non-poor* rural households.

A similar pattern is observed in sanitation, although the high prevalence of public toilets in Kinshasa (technically improved, but counted as unimproved by UNICEF and WHO [2015] due to sharing) means that the poor in other urban areas appear better served than in the capital. However, the poor in the capital and other urban areas also do significantly better in terms of improved sanitation than the rural non-poor.

Rural areas of the Democratic Republic of Congo appear to be inherently disadvantaged in terms of WASH service access. The average rural dweller not only has fewer resources to afford improved facilities, but in more remote rural areas factors such as complicated logistics, fewer economies of scale, less knowledge, and weaker institutions negatively impact access independently of available household resources.

For example, the national urban water utility REGIDESO is traditionally focused on service delivery in Kinshasa, where it is headquartered. This urban-centric service-delivery strategy was reinforced during the civil conflict of the 1990s and 2000s when many of the water supply systems outside the capital became dysfunctional. Today, 50 percent of REGIDESO's sales points and 60 percent of its annual revenue are in Kinshasa alone and donor investments have tended to reinforce a focus on major cities (see chapter 5). By contrast, not only is there no comparable state institution organizing rural supply, but providing improved WASH to the thinly spread rural population across the vast Democratic Republic of Congo is also inherently difficult.

Figure 3.11: Access, by Poverty Status, for Kinshasa, Other Major Cities, Minor Towns, and Rural Zones



Source: Enquête 123 2012.
Note: "Major cities" include the following statutory cities ("Ville statutaire"): Boma, Matadi, Bandundu, Kikwit, Mbandaka, Zongo, Gbadolite, Kisangani, Beni, Butembo, Goma, Bukavu, Kindu, Kolwezi, Lubumbashi, Likasi, Mbuji-Mayi, Mwene Ditu, Kananga, Tshikapa.

Such inherent rural disadvantages—be they institutional or other—are clearly reflected in the statistics showing better access for urban poor than rural non-poor, and logistics regressions provide further evidence that location and poverty have separate access effects (appendix F).

Trends by Location and Asset Wealth

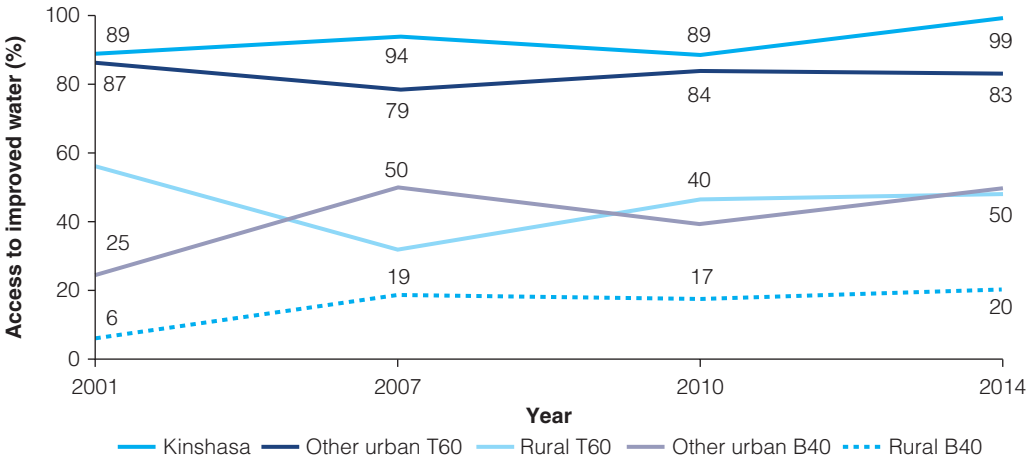
While overall progress in increasing access to improved services has been limited, trends have diverged significantly between different urban and rural areas and wealth groups. Concentrated investments in Kinshasa's water supply appear to have consolidated and raised access to improved water in the capital to near universality over the past 15 years (figure 3.12), though as has been seen, service quality problems have persisted nevertheless (figure 3.5).[11] A rebound in improved water access among the urban and rural B40 after the end of the most intense civil conflict seems to have given way to stagnation in the past 10 years. Instead, the rural T60 seem to have achieved better access over the past decade.

By contrast, the low level stagnation of safe sanitation access appears to have affected urban and rural areas and various wealth groups similarly, with the potential exception of the rural B40, which witnessed an increase of 7 percent between 2007 and 2014, possibly due in part to the EVA Program (figure 3.13).

WASH, Gender, and Children in the Democratic Republic of Congo

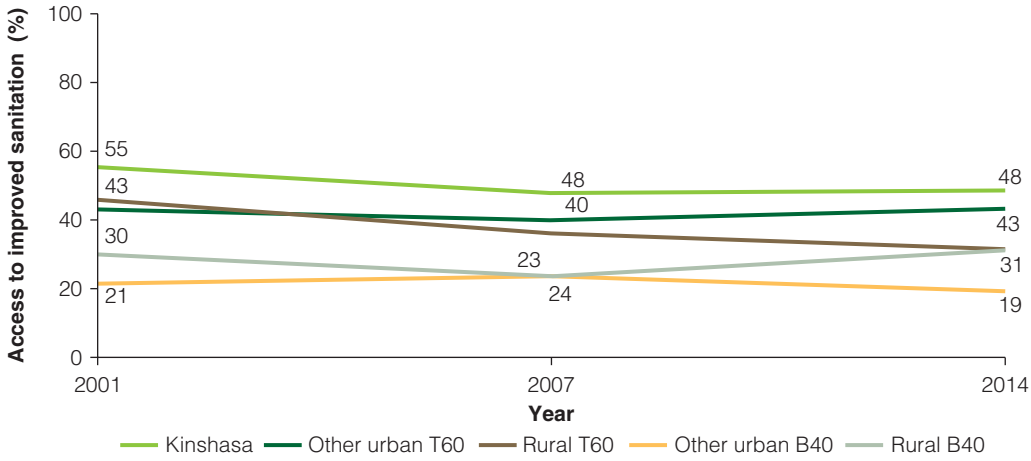
No marked differences are observed in terms of access to water and sanitation by female-headed household, but water-related responsibilities continue to be primarily carried by women and girls. While female-headed households had greater access to improved water and lower access to sanitation in rural areas in 2007, leading to a similar gap at the national level, by 2012 there is virtually no gender difference in terms of access to water and sanitation by female-headed households, even when considering poverty and wealth distribution

Figure 3.12: Change in Improved Water Access since 2001



Source: Multi-Indicator Cluster Survey (MICS) 2001; Demographic and Health Survey (DHS) 2007 and 2013–14; Enquête 123 2012.
Note: T60 = top 60 percent of households, by expenditure level. B40 = bottom 40 percent of households, by expenditure level.

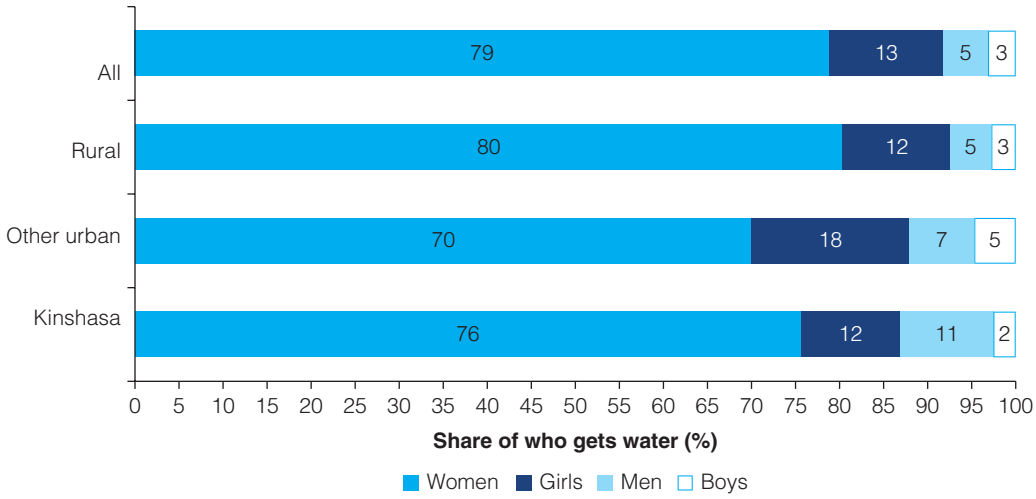
Figure 3.13: Change in Improved Sanitation Access since 2001



Source: Multi-Indicator Cluster Survey (MICS) 2001; Demographic and Health Survey (Enquête Démographique et de Santé) 2007 and 2013–14.
Note: T60 = top 60 percent of households, by expenditure level. B40 = bottom 40 percent of households, by expenditure level.

(see appendix F). On the other hand, a marked gender difference is seen when it comes to water-fetching responsibilities, with women and girls primarily carrying the load, reflecting social norms (figure 3.14). Beyond the time implication of this responsibility, tasks such as water fetching or walking to public toilets put women at risk of physical and sexual violence, which is prevalent in a fragile country such as Democratic Republic of Congo (Gonsalves, Kaplan, and Paltiel 2015; OHCHR 2014).[12]

Figure 3.14: Who Gets Water? Water-Fetching Responsibilities, by Gender



Source: Multi-Indicator Cluster Survey 2010.

Conclusion

A close analysis of the available data on WASH access in the Democratic Republic of Congo reveals a number of major policy challenges in view of the new universal SDG access targets. The majority of the population and vast majority of those lacking access to improved water remains rural. The question of rural access is closely linked to that of access for the poor, because it is the rural poor in particular who suffer from extremely low access to improved water, while the urban poor tend to profit from generally better supply in cities. Universal access, as targeted by the SDGs, will not be achieved without major efforts to improve water supply in rural areas where it has traditionally lagged.

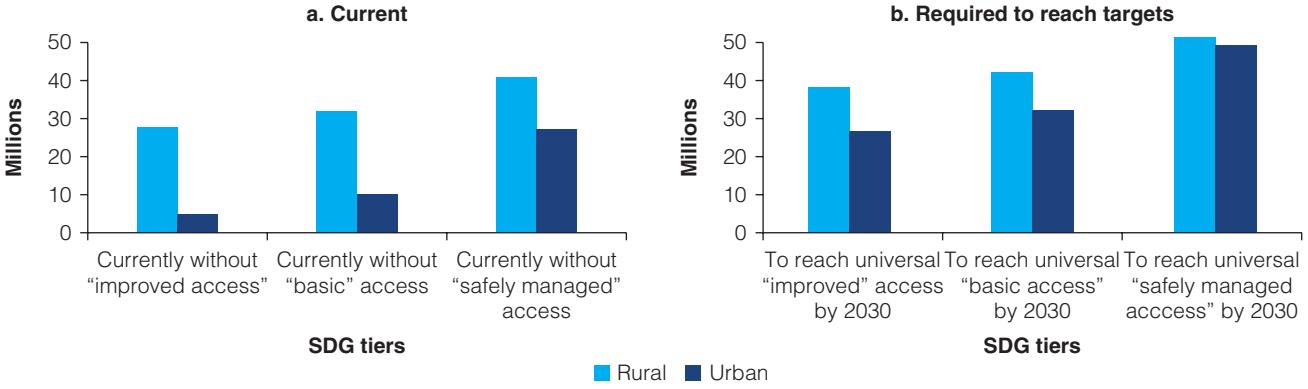
Although improved water access is overall higher in cities at present, it is eroding in the face of rapid urban population growth. In the next 15 years, urban areas are expected to add twice as many new inhabitants as rural areas (UN 2014). Major investments will be required simply to retain current access rates in cities.

Urban areas are also characterized by large access inequalities between Kinshasa and other major cities and smaller urban agglomerations. In general, secondary and tertiary cities have significantly lower improved access and should be given more attention in light of their present disadvantage and rapid growth.

Quality of access—in particular water quality—is a major concern that cuts across location and source types. As is recognized by the new SDGs, if human health and development are the ultimate aim, access to technically improved water is not meaningful if it is not easily available and truly safe to drink. Unfortunately, the available evidence suggests that improved sources are often located far from households, and contamination of water is extremely common both in urban and rural areas.

Much of the urban water access advantage relative to rural areas vanishes once access is understood as water supply that is not only technically improved, but also close by and safe to drink. Results of the WPD survey in the provincial capital of Kindu illustrates this: Kindu has improved access of 84 percent, close to the average of urban improved access in the Democratic Republic of Congo. However, this drops to 56 percent for basic water, that is, improved water within 30 minutes of a household, and to below 1 percent for safely managed

Figure 3.15: Population Currently Lacking Water Access and Expected Population Requiring Access for Universal Water Supply, by SDG Tier



Note: SDG = Sustainable Development Goal.

water as few households have continuously available sources on premises and fecal contamination is extremely widespread (figures 3.5 and 3.6). In terms of safely managed water, Kindu is thus not much different from remote rural hamlets in Equateur.

A renewed focus on quality of supply by the SDGs may redirect attention to larger cities, which are less advanced in terms of service quality, as the earlier focus on improved water had suggested (figure 3.15). Moreover, cities tend to be easier to invest in due to stronger institutions, pre-existing infrastructure, easier access, and the more concentrated, rapidly growing population. Nevertheless, the rural access problem will persist and a major challenge for the coming years will be to prevent the gap between urban and rural areas in terms of access to safely managed water to become as large as it has for improved water. As over 95 percent of Congolese currently lack safely managed access (figure 3.4), and taking into account rapid population growth, reaching the SDG targets by 2030 may require upgraded water sources for, by then, up to over 100 million Congolese (figure 3.15).

In the sanitation sector, improved access is woefully inadequate in both urban and rural areas. A positive access trend in rural areas over the past decade has not reached a scale necessary to provide improved facilities to the majority of the population, and the particularly problematic practice of open defecation has stubbornly persisted and even increased. In the dense, rapidly expanding urban areas, an access rate stagnating below 30 percent is nothing short of a public health crisis, which, as chapter 5 will detail, the current institutional structure is unable to cope with. The shift toward a more qualitatively oriented definition of sanitation under the SDGs, which seeks to include handwashing and safe disposal of fecal matter, further increases the stakes. Fewer than 2 percent of the Democratic Republic of Congo's population have access to the highest SDG sanitation tier. In light of this, the SDG target of universal access in just 15 years is truly ambitious.

This challenge is sobering, but as chapter 4 will outline, the enormous impacts of unsafe water and sanitation on health and human development only highlight the importance of achieving the SDGs, which should not only be a moral but an economic obligation for policy makers.

Notes

1. The discharge of the Congo is approx. 42,000 cubic meters per second, or 3.6×10^{12} liters per day. WHO guidance is that about 20 liters per capita per day should be assured to take care of basic hygiene needs and basic food hygiene (WHO 2016).

2. "Improved" water is defined as sources protected from contamination, especially fecal matter, by the nature of their construction and when properly used. "Improved" toilets hygienically separate human excreta from human contact. While technically "improved" status is a proxy for water safety, many improved sources (for example, covered wells) nevertheless provide contaminated water.
3. Angola, Burundi, Central African Republic, Republic of Congo, Rwanda, South Sudan, Uganda, Tanzania, Zambia.
4. Calculated as current population without access plus projected population growth in rural areas to 2030.
5. Note that the JMP methodology, which creates an overall trendline since the mid–1990s, still shows a negative trend for the past decade. However, individual surveys including DHS 2007 and 2014, and Enquête 123 in 2005 and 2012 clearly indicate a reversal in urban access rates that JMP has not yet reflected due to its particular methodological approach.
6. Data from DHS 2007 and 2014 and UN (2014).
7. All data from DHS 2014.
8. National estimates of safely managed water were calculated by combining DHS 2014 national data with results of the WPD surveys. The percentage of improved, *on-premises* sources were calculated from DHS 2014, and then the percentage of such sources free of *E.coli* and with less than a full day of interruption in the past two weeks in the *best* performing WPD survey site was applied, creating upper-bound national estimates.
9. To obtain "point of use" water, household members were asked to provide a sample of water as if they would pour themselves a glass to drink.
10. This is primarily because expenditures were adjusted by regional purchasing power, that is, effectively reweighted in favor of more rural and marginal areas in which a franc buys more than in more urban areas. Thus, for instance, the T60 by household expenditure is 60 percent rural, whereas the T60 by asset wealth is only 47 percent rural. It is likely that the greater urbanity of the top deciles by wealth drives the higher service access.
11. Note that in terms of asset wealth, Kinshasa's population is almost exclusively in the T60 group nationally.
12. Gonsalves, Kaplan, and Paltiel (2015) model the risk of a sexual assault on the number of available sanitation facilities and the total time a woman must spend walking to or from a toilet in Khayelitsha, South Africa, which has an estimated 5,600 toilets in 800 separate locations. According to their study, the average round-trip travel distance to and from a toilet is 210 meters; at six trips per day and 2–5 minutes per trip, this suggests an assault risk exposure time of 15 minutes per woman per day. This results in 635 sexual assaults per year, creating USD 34 million in assault-related social costs. The direct annual cost of operating the township's toilets is USD 6 million, thus the combined annual social cost associated with the current allocation of toilets is USD 40 million. According to an April 2014 report of the Office of the United Nations High Commissioner for Human Rights (OHCHR) sexual violence remains "extremely serious due to its scale, systematic nature and the number of victims" (OHCHR 2014). With more than 40 percent of the B40 traveling over 30 minutes for water, this consideration of gender vulnerability induced by poor WASH is of primary importance in the Democratic Republic of Congo.

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Chapter 4
WASH, Nutrition, and Health: The Foundations of Long-Term Development

Key Points

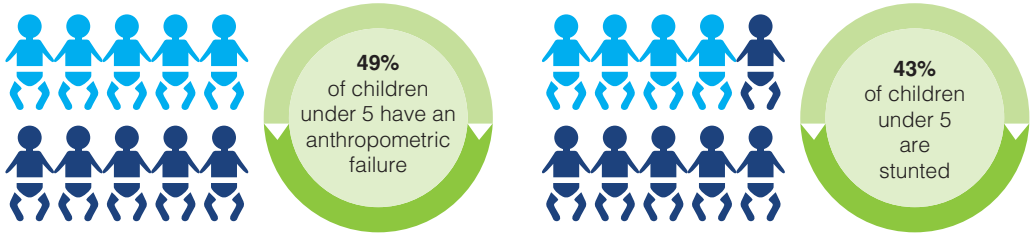
- A silent emergency to which water, sanitation, and hygiene (WASH) is a key contributing factor is placing Democratic Republic of Congo's poor and rapidly growing population at risk of permanent disconnect: widespread malnutrition.
- Malnutrition is particularly common among Democratic Republic of Congo's children (43 percent in 2014) and has been shown to have irreversible negative effects on physical and cognitive development.
- WASH is closely linked to malnutrition, stunting, and related health problems, such as diarrhea, ranking among the top five risk factors associated with death and disability in the Democratic Republic of Congo.
- New evidence by the WASH Poverty Diagnostic (WPD) demonstrates a significant reduction in the risk of anthropometric failure among children under five with access to uncontaminated safely managed water.
- Food-security focused interventions have been estimated to address only 20 percent of the stunting burden. With WASH as one of the key contributing factors to malnutrition, the sector can play a key role in addressing the other 80 percent.
- The nexus of WASH and nutrition highlights important priorities for policy makers:
    - The new Sustainable Development Goal (SDG) focus on quality of WASH services is of critical importance for what matters most: human health. Contaminated improved facilities are a part of the problem.
    - Cross-sectoral interventions incorporating high-quality WASH along with factors such as food security, maternal education, and natal care are likely to have most impact on health.
    - Fail-safe interventions directly targeting water quality—for example, point-of-use treatment—may help alleviate health impacts among the most vulnerable until infrastructure is in place.

Malnutrition: A Silent Emergency

Malnutrition in Democratic Republic of Congo is appallingly high for a country well endowed with natural resources. In spite of its vast and largely untapped arable land, combined with important water resources and a favorable climate allowing several annual harvests, food insecurity and malnutrition are rampant in Democratic Republic of Congo. The data from the latest national survey (Demographic and Health Survey [Enquête Démographique et de Santé] [DHS-EDS] 2014) reveals that 49 percent of under five year olds in the Democratic Republic of Congo suffer from some type of anthropometric failure, with a staggering 43 percent chronically malnourished (figure 4.1).[1] Close to 23 percent are severely and 8 percent acutely malnourished.

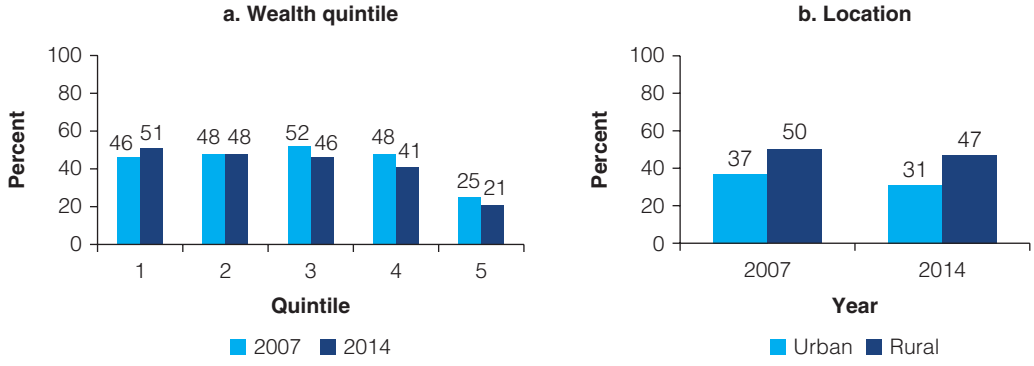
Malnutrition in the Democratic Republic of Congo is pervasive across wealth quintiles, with only the richest doing significantly better. The prevalence of stunting in Democratic Republic of Congo is rather uniform across the wealth distribution with only the top quintile significantly less stunted than the other wealth groups. Notably, however, the poorest quintile was the only one to see stunting increase after 2007 (figure 4.2). The WPD survey showed just how widespread anxiety about nutrition is. Even in the capital Kinshasa, almost 60 percent of the non-poor had worried about not having enough to eat over the past 12 months, and over 75 percent of the poor. In the provincial capital of Kindu, close to 73 percent of the non-poor had suffered the same anxiety, and over three-quarters of the poor.

Figure 4.1: Pervasive Malnutrition in Democratic Republic of Congo



Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2014; World Bank calculation.

Figure 4.2: Stunting in Children Under Five, by Wealth Quintile and Location Type



Source: Demographic and Health Survey (Enquête Démographique et de Santé), 2007 and 2014.

While child malnutrition is common across the Democratic Republic of Congo, important spatial variation can be observed. Stunting is more prevalent in rural than in urban settings (figure 4.2) and important spatial disparities exist between and within provinces. While under five stunting in Kinshasa is relatively low, at 15 percent in 2014, it towers at 53 percent in the North and South Kivu. The survey conducted by the WPD also documented important variations even at municipal level. While the capital's central commune of Kinshasa has a stunting rate of only 6 percent, up to 20 percent of under five year olds in the peri-urban commune of Kimbanseke are stunted.

Malnutrition is an acute health risk and can also have long-term negative effects. Stunting is a powerful risk factor for disease and death and is associated with 53 percent of infectious disease-related deaths in developing countries (Schaible and Kaufmann 2007). The risk of dying is increased 1.6-fold in a moderately stunted child and by more than 4.1-fold in a severely stunted child (Black et al. 2008; Caulfield et al. 2004). Malnutrition can also have long-lasting negative physiological effects including "a reduced capacity for manual work […] poor mental development and school achievement as well as behavioral abnormalities" (Martins et al. 2011) and "even malabsorption of drugs needed to combat diseases like AIDS, tuberculosis, and malaria, which often coexist with malnutrition and diarrhea"(Guerrant et al. 2008). This risks long-term disadvantages for affected individuals, and in the Democratic Republic of Congo's case of extremely widespread malnutrition, the country as a whole.

The Link Between WASH, Health, and Malnutrition

Concern about WASH lies at the very origin of the discipline of public health. John Snow's famous discovery of a fecally contaminated well as the source of a major cholera outbreak in London in 1855 is often cited as the start of public health as a concern of public policy. Low-quality access to WASH has since been linked to many disease outcomes, including diarrhea, parasite infections, and malaria (Prüss-Ustün et al. 2014).

The link between WASH and malnutrition has emerged as a particularly insidious one. Three biological mechanisms have been identified that link unsafe WASH to malnutrition and its negative health effects (Cumming and Cairncross 2016, 95):

> "(1) Via repeated bouts of diarrhea (Briend 1990; Checkley et al. 2008; Petri et al. 2008; Richard et al. 2013);
> (2) Soil-transmitted helminth infections […] (O'Lorcain and Holland 2000; Prüss-Üstün and Corvalán 2006; Hall et al. 2008; Ziegelbauer et al. 2012); and
> (3) A subclinical condition of the gut, referred to variously as tropical enteropathy (Baker and Mathan 1972; Humphrey 2009), environmental enteropathy (Fagundes-Neto et al. 1984; Korpe and Petri 2012) or, most recently […] environmental enteric dysfunction (Crane, Jones, and Berkley 2015; Haghighi, Wolf, and Durie 1997; Humphrey 2009; Keusch et al. 2014).

In each of these pathways, enteric pathogens and associated infections that inhibit nutritional uptake are transmitted through contaminated water and unsafe sanitation (see appendix G for the WASH–Nutrition pathways). Empirical research has demonstrated the link between WASH and health outcomes in the field both at village and cross-country level. Duflo (2015) and colleagues show that the provision of integrated water and sanitation improvement programs at the village level has a substantial impact on reducing the incidence of diarrhea in that village. Danaei et al. (2016) highlight unimproved sanitation as one of the leading risk factors for stunting in a cross-country study in 137 developing countries.

Anemia—low levels of oxygen-carrying hemoglobin that negatively impact child growth and development—is also related to poor WASH and reinforces direct malnutrition effects. Iron-deficiency anemia (IDA) reinforces negative effects on cognitive development during infancy, childhood, and adolescence, and is associated with faltered growth

(Soliman 2014) and malnutrition (Ngure et al. 2014). Anemia has been connected to WASH through the familiar pathways of environmental enteropathy and helminth infections, as well as the water-related disease malaria. Environmental enteropathy not only reduces nutritional uptake directly, but impairs hemoglobin production through inflammation effects (Ngure et al. 2014). Helminth parasites not only compete for nutrition, but contribute to anemia through blood loss, while malaria parasites destroy red blood cells directly. The incidence of anemia is high in Democratic Republic of Congo. In 2014, the rate of anemia in infants aged between 6 and 24 months was as high as 43 percent, on par with that of stunting.[2]

As would be expected based on known biological mechanisms and international evidence, unsafe water, sanitation, and hygiene are closely related to under-five morbidity and mortality in the Democratic Republic of Congo. Indeed, WASH is one of the top five risk factors associated with death and disability in Democratic Republic of Congo (IHME 2015).[3] According to the latest national survey (DHS-EDS 2014), diarrhea was the cause of 15 percent of deaths of under five year olds in the Democratic Republic of Congo. The same survey indicates that prevalence of diarrhea in children under five was close to 20 percent in an urban setting, and 16 percent both nationally and in rural settings.[4] While food insecurity is the leading factor, unsafe WASH access is a contributing risk that further weakens nutritional and health outcomes, and thus the foundations of early childhood development. As can be seen in figure 4.3, this risk is especially high in earlier years of life (years lived with disability, YLDs). The Democratic Republic of Congo is above the average for Africa in terms of disability-adjusted life years (DALYs) attributable to unsafe WASH.[5]

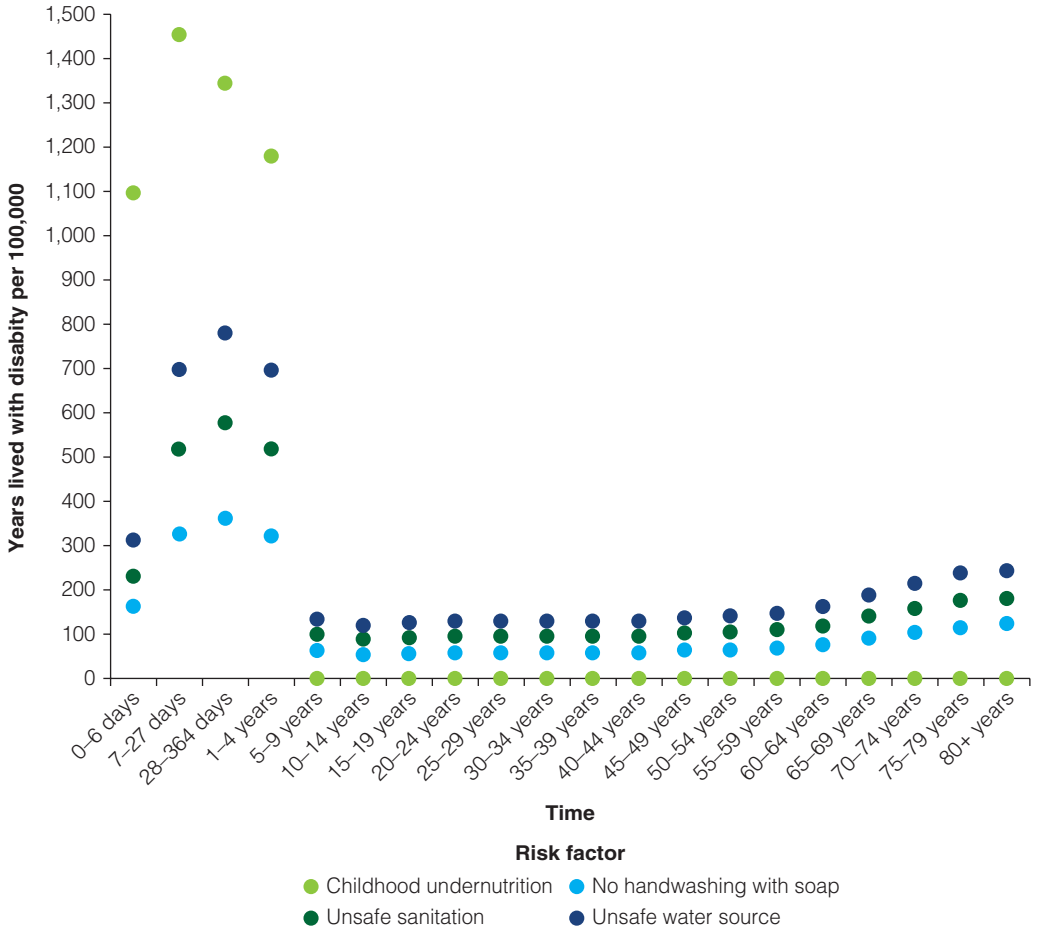
Water contamination is found to be high in areas of high incidence of anthropometric failure in the Democratic Republic of Congo. The household survey and water quality testing done as part of the Democratic Republic of Congo WPD confirm a high level of *E. coli* contamination in areas with high anthropometric failure, in particular in provincial sites outside Kinshasa (figure 4.4 and table 4.1).[6]

In the Democratic Republic of Congo, a reduction in the probability of anemia as well as malaria is consistently and significantly associated with improved access to water and sanitation (appendixes M, N, Q, R, and S). This result, based on national survey data (DHS-EDS 2014), shows that improving WASH in the Democratic Republic of Congo has a significant effect on anemia and its negative impact on child mortality and early childhood development, which aggravate similar effects stemming from malnutrition. While the results indicate a correlation rather than a causal pathway, it could suggest that improved water and sanitation facilities are likely reduce helminth and malaria infection by limiting water contamination by worms and mosquito larvae.

Improved WASH Is Not Enough: The Importance of SDG WASH Targets for Nutrition and Health

While improved WASH facilities significantly reduce the risk of anemia in the Democratic Republic of Congo, no statistically significant association between *improved* water and malnutrition itself is evident in recent national survey data (DHS-EDS 2013-14). Regression analysis using the 2014 DHS data shows the expected negative direction of the effect of improved water on the risk of stunting and other anthropometric failures (composite index of anthropometric failures, or CIAF), but the effect is not statistically significant, unlike other contributing factors such as the gender of the child (boys appear to be more exposed), the education of the mother, length of breastfeeding (in months), location (new provinces), and wealth[7] (appendixes H, I, J, K, L). As outlined above, it appears that standard improved water sources significantly reduce anemia, possibly by limiting helminth and malaria infections, but do not protect significantly against fecal contamination related malnutrition.

Figure 4.3: Years Lost Due to Disability (YLD) for People Living with a Health Condition or its Consequences in Democratic Republic of Congo

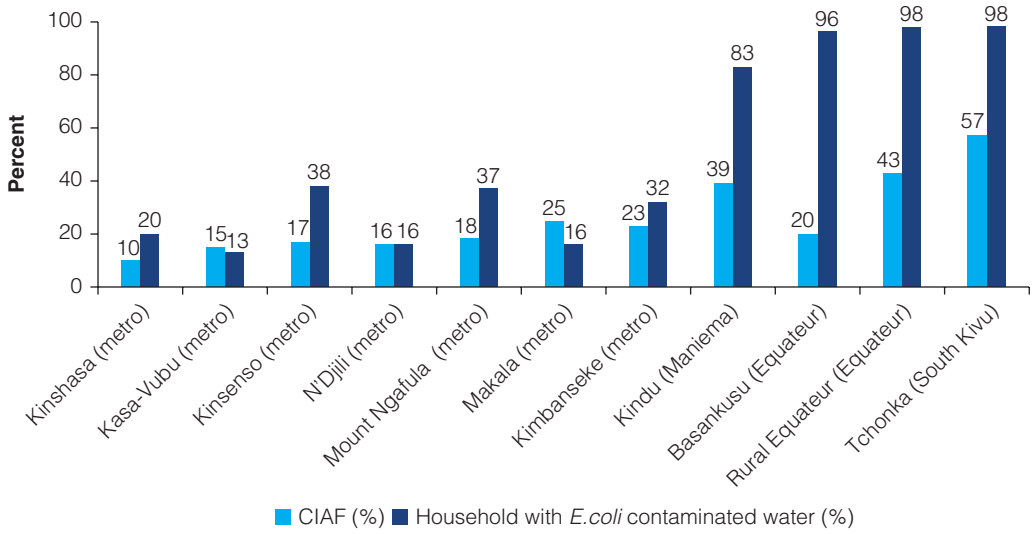


Source: IHME 2015.

This result is not surprising given the high rate of fecal contamination of improved water sources demonstrated by the WPD survey and very low access to safely managed sanitation. It is unlikely that improved water would significantly impact malnutrition if it is not, in fact, free of fecal contaminants. Similarly, improved sanitation is unlikely to lead to strong positive effects on malnutrition or properly protect improved water sources from contamination if even households with improved facilities do not have access to safe disposal of the temporarily contained sludge, if overall access levels are so low that cross-contamination from other households is likely, and if handwashing with soap after toilet use is almost unknown.

The insufficient protection improved water sources provide against malnutrition is aggravated by the extremely low level of point-of-use water treatment, which has clear protective effects. According to the latest DHS-EDS (2014), less than 2 percent of household with access to an improved water source treat their water in any way. Only two provinces have treatment rates over 4 percent (Kinshasa and Katanga), while the rest of the provinces hover between 1.0 and 3.8 percent. With the exception of Kinshasa, where boiling is the prevalent method of water treatment. Treatment with bleach/chlorine is the preferred method of treatment in Democratic Republic of Congo (figure 4.5).

Figure 4.4: Composite Index of Anthropometric Failures (CIAF) and Water Contamination with *E. coli*



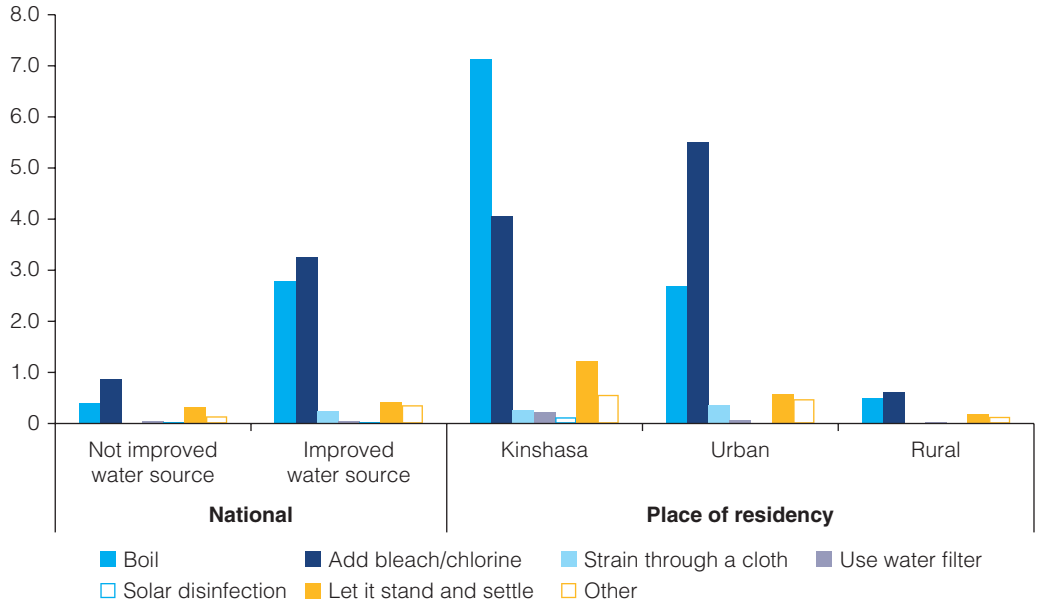
Source: Congo, Dem. Rep., Water, Sanitation, and Hygiene Poverty Diagnostic (WPD) survey 2016.

Table 4.1: Anthropometric Failures and *E. coli* Contamination
Percent

	Stunting rate (percent)	CIAF (percent)	Wasting (percent)	Underweight (percent)	*E. coli* contamination (percent)
Kinshasa (metro)	5.8	9.8	5.3	4.4	20.0
Kasa-Vubu (metro)	9.2	15.1	2.9	10.8	13.0
Kinsenso (metro)	9.3	16.7	3.1	3.6	38.0
N'Djili (metro)	10.3	16.0	6.6	6.2	16.0
Mount Ngafula (metro)	15.0	18.2	6.7	10.5	37.0
Makala (metro)	17.2	24.7	2.8	5.1	16.0
Kimbanseke (metro)	19.8	22.7	5.3	3.9	32.0
Kindu (Maniema)	32.9	39.1	5.7	15.6	83.0
Basankusu (Equateur)	20.0	20.0	0.0	0.0	96.4
Rural Equateur (Equateur)	33.9	43.0	5.1	15.3	97.8
Tchonka (South Kivu)	46.3	57.2	6.6	27.5	98.4

Source: Democratic Republic of Congo, Water, Sanitation, and Hygiene Poverty Diagnostic (WPD) Survey 2016.
Note: CIAF = composite index of anthropometric failures.

Figure 4.5: Water Treatment across Settings in Democratic Republic of Congo



Source: World Bank calculation; Demographic and Health Survey (Enquête Démographique et de Santé) 2014.

Table 4.2: Odds Ratio for Malnutrition Outcome and Water Treatment, 2014

	CIAF	Stunting
Any treatment (0–59 month olds)	0.363 ***	0.332***
Any treatment (6–23 month olds)	0.260***	0.195***
Any treatment (24–59 month olds)	0.364***	0.336***

Source: Data from Demographic and Health Survey (Enquête Démographique et de Santé) 2014.
Note: CIAF = composite index of anthropometric failures.

Looking at the correlation between CIAF or stunting and water treatment shows that all treatments, with the exception of letting the water settle, are associated with a reduction of anthropometric failures. Treatment by boiling and chlorine/bleach is most strongly associated with a negative correlation, in part due to their relative prevalence of use compared to the other techniques. Regardless of the age group considered, with any water treatment the odds of stunting/wasting/undernutrition are significantly lower (table 4.2). This confirms that renewed attention to water quality and water treatment, and the delivery mechanism and behaviors required for sustained and systematic use is warranted to address malnutrition in Democratic Republic of Congo, as long as the available infrastructure does not reliably deliver safe water and sanitation.

While improved water is not enough to achieve significant protective effects, data collected by the WPD confirms that access to safely managed water (SDG tier 3) and improved sanitation reduce the probability of stunting and anthropometric failures by about 5 percent in children under 5.[8] The household survey data collected in Kinshasa with water-quality testing confirm that access to truly safe WASH (that is, inclusive of the quality factor not accounted for in other surveys available) does significantly improve children's nutritional

status (appendix P).[9] Access to safely managed clean drinking water helps to reduce children's probability of stunting by 4–5 percent on average, which is both economically and statistically significant. Access to improved sanitation also reduces the probability of anthropometric failures in the same range. Interestingly, household wealth does not seem to matter much, whether measured by a wealth index or an expenditure per capita measure based on the Survey of Well-being via Instant and Frequent Tracking (SWIFT) methodology.[10,11] Such results are indicative of the potential role of water quality as an equalizer. If safely managed, uncontaminated water can be made available, the probability of anthropometric failures in general, and stunting in particular, can be reduced regardless of poverty status. Although SDG targets for safely managed WASH are extremely ambitious, they are clearly a necessary step beyond improved access for the outcome that matters most: human health and development.

Cross-Sectoral Interventions to Target the WASH–Malnutrition–Health Nexus

Cross-sectoral interventions with safe WASH as an integral element will be critical to alleviate the malnutrition crisis that threatens the Democratic Republic of Congo's future. The United Nations Children's Fund (UNICEF) Synergy framework on malnutrition considers four key dimensions: food security, childcare practice, health, and WASH (that is, "adequate environment").[12] The fundamental idea is that substantial interactions and synergies exist among these dimensions. The Democratic Republic of Congo, survey data (DHS-EDS 2014) shows that 41 percent of children under 24 months have inadequate access to all four of these dimensions, with access to adequate WASH most lagging.

The WPD's analysis of the latest national data for the Democratic Republic of Congo shows how WASH interventions may enhance improvements in other key dimensions of the UNICEF framework (appendix V). While an average child with an adequate supply of food is only 0.5 standard deviations (SD) taller than a child not adequate in any dimension, a child adequate in both food and care is 0.7 SD taller while child adequate in food and WASH/environment is 1.2 SD taller.[13] Indeed, for the bottom 40 percent of the wealth distribution (B40), access to food alone is not sufficient for a significant impact on height-for-age, but must be accompanied by access to another of the three dimensions. These results suggest that although in the Democratic Republic of Congo access to adequate food is of paramount importance in nutritional outcomes, particularly in poor households, meeting additional conditions such as safe WASH access is critical to achieving a statistically significant improvement in child height compared to no access. Including WASH in malnutrition interventions is thus critical in the Democratic Republic of Congo.

Direct undernutrition interventions, even when scaled up to 90 percent coverage rates, have been estimated to address only 20 percent of the stunting burden (Bhutta et al. 2013). As one of the key complementary determinants of better nutrition outcomes, the water and sanitation sector can help address the other 80 percent. The latest *Global Nutrition Report* (IFPRI 2016) estimated the thresholds of a set of key determinants—water and sanitation along with calories, education, and female empowerment—which are needed to reduce stunting to 15 percent.[14] These thresholds can serve as a starting point for countries to inform their targets and policies as well as to mobilize partners toward common goals across sectors.[15] Table 4.3 presents the thresholds identified and gaps between thresholds needed to reach a predicted stunting rate of only 15 percent, and actual values in the case of the Democratic Republic of Congo.

While the Democratic Republic of Congo has vulnerabilities across the six drivers, the gaps in access to improved water and sanitation are particularly wide. While food security (per capita calories in food supply) remains a major issue with a gap of 28 percentage points compared to the threshold, the gap in the area of water and sanitation are also wide. Countrywide,

Table 4.3: Thresholds for Underlying Drivers to a Predicted Stunting Rate of Less than 15 percent

Six underlying drivers	Threshold corresponding to a prediction of stunting prevalence of <15%	Present value in the Congo, Dem. Rep.
Total per capita calories in food supply	2,850 cal.	2,056 (2009)
Calories from non-staples	51%	na
Access to improved water	69%	52 % (2015)
Access to improved sanitation	76%	29 % (2015)
Female secondary school enrollment rate	81%	38.2% (2014)*
Ratio of female to male life expectancy (proxy for the empowerment of women)	1.072	1.051 (2014)

Source: IFPRI 2016; World Bank 2017; JMP (UNICEF and WHO 2015), UIS 2017.
Note: JMP = Joint Monitoring Program.

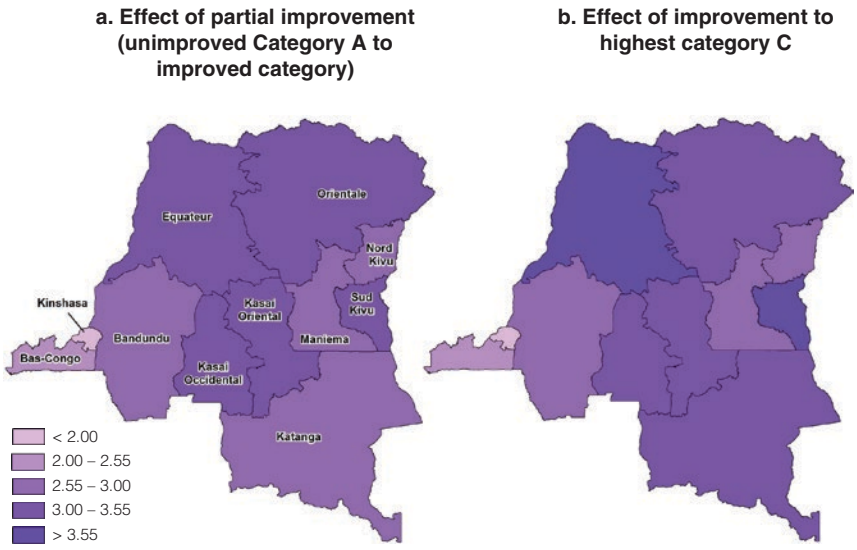
sanitation presents a gap of over 40 percentage points, while in rural areas the gap is important for both water and sanitation, respectively a gap of 36 and 44 percentage points, to reach a predicated stunting threshold of 15 percent. As noted in chapter 3, access to truly safe water is significantly lower still than data on improved WASH access suggests.

Cross-sectoral approaches that include WASH in malnutrition interventions are increasingly piloted. One such example is the WASH in Nut (or WiN) program developed in the context of food-security emergencies in the Sahel region which targets nutrition/feeding centers and children suffering from severe malnutrition. Organized around a "minimum WASH package," the WASH in Nut (or WiN) strategy is a tool targeting, in a specific and integrated way, mothers and severely malnourished children, from health infrastructure to communities.[16] The WASH in Nut strategy is now endorsed in the Humanitarian Action Plans of eight countries in the Sahel and, more recently, by the Democratic Republic of Congo (WASH Cluster 2015).

The strategy is being progressively extended to non-emergency approaches with the objective of enhancing nutrition outcomes in countries with a high malnutrition burden. A further expansion linking this humanitarian approach to those undertaken in development could help achieve greater and more sustainable outcomes. If WASH is an underlying driver of nutrition, nutrition can also be a vector to improve WASH outcomes through other sectors and delivery mechanisms, particularly in hard-to-reach vulnerable populations in which single-sector interventions may not be cost-effective.

Protecting the basics: WASH interventions targeting nutrition and health must place particular emphasis on ensuring high water quality efficiently. Building infrastructure that can deliver truly clean water and a fully safe sanitation chain is a long-term project. In the short run, "fail-safe" stop-gap interventions, such as treatment at point of use, may also be considered as part of nutrition-focused projects, especially in vulnerable areas in which high-quality infrastructure is not yet cost-effective. Evidence suggests that point-of-use treatment can achieve take-up rates of up to 70 percent and reduce child diarrhea by 20–40 percent (Arnold and Colford 2007; Clasen and Edmondson 2006; Fewtrell et al. 2005; Kremer, Ahuja, and Zwane 2010; Sobsey 2002; Waddington and Snilvsteit 2009). Such interventions may also minimize recontamination in the home, a well-known cause of water quality degradation even in the best-case scenario of access to clean piped water. While not sufficient alone, point-of-use water treatment can be a cost-efficient WASH intervention to protect key nutritional outcomes in under-five-year-old children, thereby protecting Democratic Republic of Congo's richness, that is, its people and potential for shared prosperity.[17]

Map 4.1: Effect of Water Access Improvement on Disease-Risk Reduction



Source: Rheingans et al. 2016; Demographic and Health Survey (Enquête Démographique et de Santé) 2014.

Cross-sectoral nutrition- and health-focused interventions that integrate WASH should balance cost-effectiveness with a focus on severity of needs, which are concentrated in certain provinces. From a needs perspective, risk to children's health is particularly high in Equateur, Orientale, Kasaï Oriental, Kasaï Occidental, and South Kivu. A new WASH Poverty Risk Model (PRM) developed in the context of this diagnostic combines key "susceptible factors" and "exposure factors" most relevant to the incidence of diarrhea. A description of PRM and main results can be found in appendix X.[18] The PRM analysis shows that while all children in all regions would benefit from water and sanitation improvement, children from the provinces of Equateur, Orientale, Kasaï Oriental, Kasaï Occidental, and South Kivu would experience the highest heath risk reduction in response to water or sanitation access improvements. (See map 4.1 for a map on improvement in water and appendix X for those related to sanitation.) As Box 4.1 further highlights, the factors influencing malnutrition risks are complex and may also vary with local factors at the sub-province level such as closeness to mining sites or political violence.

Implications of the WASH–Nutrition Nexus for Policy Makers

The nexus of WASH and nutrition highlights important lessons for policy makers. First, the new SDG focus on the quality of WASH services is of critical importance to address the major health problem of WASH-related diarrhea and malnutrition. Contaminated improved facilities are part of the problem, contributing to acute and long-term negative health effects in the Democratic Republic of Congo. Fail-safe interventions directly targeting water quality, such as point-of-use treatment, may help alleviate health impacts among the most vulnerable until adequate infrastructure is in place. Second, cross-sectoral interventions incorporating high-quality WASH along with factors such as food security, maternal education, and natal care are likely to have most impact on health. Finally, a careful analysis of risk factors can help direct interventions to areas of highest impact.

Box 4.1: The Complex Influences on WASH Quality and Nutrition: Fragility and Mining

The quality of water and degree of malnutrition are influenced by a complex array of factors, not always at household level. The impact of political violence and economic activity are important examples.

Fragility remains an issue with lasting implications in the Democratic Republic of Congo, including for public health. The effects of the Democratic Republic of Congo's protracted instability extend beyond the direct casualties of organized violence, and include many less visible consequences. Using the data from the Armed Conflict Location and Event Data Project (ACLED), different variables were constructed to capture the incidence of violence.[a] The results show that the distance from the closest headquarters of an armed group is positively correlated with anemia and malaria, meaning that children living closer to armed groups face a significantly higher likelihood of being anemic or suffering from malaria. The results are not significant for stunting or anthropometric failures (appendix Q).[b] While this analysis captures only a small aspect of the overall tragedy of political violence in the Democratic Republic of Congo, it indicates how state fragility can impact and complicate public health crises.

The importance of mining in the Democratic Republic of Congo's economy is another factor affecting water quality and malnutrition in many areas of the country. Democratic Republic of Congo is a resource-rich country and mining represents a sizable and growing share of the country's GDP.[c] In a context of low governance, this economic bounty has faced little environmental regulation and monitoring. In a 2011 report, UNEP estimated that around 15 tons of mercury are used annually in the Democratic Republic of Congo's artisanal gold mining operations, the second largest source of mercury emissions in Africa (UNEP 2011). This is of particular concern for populations relying on unprotected water sources. While no data exists on the contamination resulting from mining activities, we used a dataset on the localization of mining permits granted by the Congolese government to proxy for mining sites.[d] Map T.1 in appendix T shows the proximity of these sites to rivers in the Democratic Republic of Congo.

The results show that stunting is indeed higher in areas close to mining activity (appendix T). Controlling for other key variables (wealth, mother education, gender, breastfeeding, and others), close to 50 percent of children under five living in household less than 5 kilometers from a mining site are stunted, whereas children living further from such sites are comparatively less stunted (below 40 percent). Children under five living closest to mining sites also tend to have less access to improved sanitation and are less likely to have access to improved, basic, and safely managed water than children residing further away. While these results fall short of proving a direct relationship between unsafe mining and malnutrition, they do indicate the existence of negative socioeconomic and environmental dynamics impacting nutrition (appendixes T and U). The reliance by poor populations on unsafe natural resource extraction combined with the persisting gap in access to improved WASH infrastructure exemplifies the extreme vulnerability of those populations to additional contamination of their water resources, warranting further attention and research to expand on the anecdotal evidence already flagging this concern.[e]

a. Using the ACLED database, several conflict/violence variables are constructed namely: number of strategic events (battles, strategic development and non-violent transfer of territories) within a 10–50 kilometer radius; the number of events with violence against civilians within a 10–50 kilometer radius; the number of the strategic events with fatalities; and the number of the civilian events with fatalities. The variables are defined as the number of events in the 12 months prior to the beginning of the survey and the five years prior to the beginning of the survey. The correlations among the variables are high. Additionally a variable using the distance to the closest military headquarters is included in the analysis.
b. Other variables, such as the number of events with facilities, are less stable across specifications. For instance, taking a quantile perspective, the younger age group 6–23 months), the three lower quantiles of height (20th, 40th, and 60th) show a positive correlation with the number of events with fatalities in the prior five years within a 10 kilometer radius. With military action endogenous, one of the possible reasons could be that relatively better-off areas are more desirable targets for warring factions (see appendixes 16–18 for all results).
c. Mining production accelerated from 2007 onward and mining exports more than doubled between 2009 and 2014. Mining and oil represented 97 percent of the country's exports and 33 percent of GDP in 2014. Mining is only one of the extractive and forest-based activities with potential implications for water quality. We focus on mining due to its visibility, important contribution to Democratic Republic of Congo's growth, and data availability.
d. It is possible, however, that some concessions have remained unexploited.
e. See, for instance, Jeune Afrique (2016) and Mateso (2016).

Notes

1. Stunting and the Composite Index of Anthropometric Failures (CIAF) are used to capture the overall extent of undernutrition among children. Stunting is a cumulative measure of both acute and chronic undernutrition and tends not to vary instantaneously in response to acute conditions, such as diarrhea or measles. This makes it a preferred indicator of aggregated deprivation over time. The composite index of anthropometric failure (CIAF) has been proposed (Svedberg 2000) and used (Nandy et al. 2005) to provide an unequivocal statement on the direction and degree of change in undernutrition over time which is useful in a context of high vulnerability, such as Democratic Republic of Congo. CIAF allows the analysis to systematically capture the different combinations of anthropometric failures (that is, including wasting and underweight in addition to stunting). Still, stunting is the main contributor to CIAF in Democratic Republic of Congo and captures more than 80 percent of children with anthropometric failures.
2. Anemia testing is only conducted for children aged 6–59 months.
3. The risks by cause analysis looks at the total burden of deaths by risk factor and how risk factors affect 21 broad cause groups. Data used to estimate cause-specific mortality for the 2013 Global Burden of Disease come from vital registration, verbal autopsy studies, maternal and child death surveillance, and other sources covering 14,244 site-years (years of cause of death data by geography) from 1980 through 2013. Data from 35,620 epidemiological sources were used to estimate the prevalence of the diseases. Cause-specific mortality for most causes was estimated using the Cause of Death Ensemble Model strategy Global Burden of Disease Pediatrics Collaboration (2016).
4. The indicator capture the incidence of diarrhea in the two weeks prior to the survey in children below 59 months of age.
5. YLD is an abbreviation for years lived with disability, which can also be described as years lived in less than ideal health. This includes conditions that may last for only a few days or a lifetime. It is measured by taking the prevalence of the condition multiplied by the disability weight for that condition. Disability weights reflect the severity of different conditions and are developed through surveys of the general public. DALY stands for disability-adjusted life year. It is a metric that allows researchers and policymakers to compare different populations and health conditions across time. DALYs equal the sum of years of life lost (YLLs) and years lived with disability (YLDs). One DALY equals one lost year of healthy life. DALYs allow the estimation of the total number of years lost due to specific causes and risk factors at the country, regional, and global levels (IHME).
6. Interestingly, while stunting is high, wasting and underweight are lower, even in areas of high contamination (table 4.1). This could suggest that while children suffer from regular food insecurity and shortfalls (as reflected by the high number of respondents worried about not having enough to eat, see above), they are not suffering from acute malnutrition. Rather, high stunting reflects an aggregated effect of inadequate dietary intake and infectious diseases over time that reduce metabolic requirements and increase nutrient loss, compounded by the effects of poor water quality and unsafe sanitation. A separate paper on issues related to nutrition, WASH and poverty will expand the analysis using the Democratic Republic of Congo WPD survey data.
7. A typical DHS Wealth Index excluding the WASH variables is used.
8. Safely managed water refers to a definition of access that is improved, on premises, continuous and *E. coli* free. The water testing at point of use was conducted for a sub-sample of households interviewed for the Democratic Republic of Congo WPD.
9. Limitation in data in the case of Kinshasa prevented the inclusion of breastfeeding and mother education in the regression analysis. Other control variables used in the previous analysis of DHS data were included. The analysis will be expanded to the other sites covered by the Democratic Republic of Congo WPD survey where the missing controls are available.
10. While the wealth index is significant—reducing the probability of stunting/anthropometric failure as expected—in some specifications, coefficients are very small when this is the case.

11. Developed by the World Bank, SWIFT stands for Survey of Well-being via Instant and Frequent Tracking. SWIFT collects data from samples that are representative of underlying populations of interest. SWIFT applies a series of formulas/algorithms, as well as the latest ITS technology, to cut the time and cost of data collection and poverty estimation. For example, SWIFT does not estimate poverty from consumption or income data, which is time-consuming to collect, but uses formulas to estimate poverty from poverty correlates, which can be easily collected. The 2012 LSMS for Democratic Republic of Congo was used to define the variables required to relate poverty estimates to the expenditure based measurement; that is, to define imputed log per capita expenditure.
12. The adequate environment (WASH) measure is based on adjusted definitions adopted by WHO/UNICEF JMP as part of the monitoring of the SDGs. They include components on: access to improved drinking water; access to improved sanitation; adequate handwashing practices; and adequate disposal of child's feces. Given that it is not only the child's immediate environment, that is, the facilities in the dwelling unit, but also those in the immediate neighborhood which affect the degree of exposure to pathogens, community-wide access to improved sanitation is also explored. Further details on the econometric model and definition used can be found in appendix V.
13. The coefficient estimate for food and environment is based on only 11 observations (0.4 percent of the sample), but the food and health estimate is based on 74 observations (2.4 percent of the sample). That is, the average height-for-age z score (HAZ) for children with access to food and health is 0.4 SD.
14. This 15 percent stunting cutoff is arbitrary but does correspond to the approximate stunting prevalence in 2015 for 100 million stunted children, the World Health Assembly (WHA) target for stunting in 2025 (IFPRI 2014).
15. The underlying driver thresholds are calculated by fitting a line to a cross-plot of stunting and each of the underlying drivers using data from all countries that have available data for all six underlying drivers. The threshold for, say, available calories per person per day is determined by the calorie level above which we would estimate a stunting rate, on average, of less than 15 percent (2,850 calories). This is done for all six underlying drivers. In total, 98 countries were included in the definition of those thresholds, including Democratic Republic of Congo (IFPRI 2016).
    Note: Several studies provide estimates that link stunting to a range of underlying drivers. Smith and Haddad (2015) analyzed variation across a number of countries over time, while Headey and Hoddinott (2014) and Headey (forthcoming) analyzed variation within a given country over time.
16. The strategy is centered on mainstreaming a WASH "minimum package" in humanitarian programs. This strategy recommends three main groups of activities: improving WASH conditions in nutrition centers and reducing the risks of nosocomial infection among children who receive treatment; providing a hygiene kit and giving advice to families in order to improve treatment and reduce risks of relapse; improving the WASH environment in communities at risk of undernutrition to prevent new cases (Regional WASH Working Group 2012). The WASH in Nut strategy was developed over several years after the 2005 food crisis, but received a "push" from the crisis in 2011–12 and was then formalized.
17. While no recent study on the cost effectiveness of water treatment exists, a WHO/UNICEF study postulates that household water treatment can pay back USD 60 for every USD 1 invested (WHO/UNICEF Joint Monitoring Programme 2005).
18. A self-standing report on the Poverty Risk Model (PRM) analysis for Democratic Republic of Congo is also part of the delivery package of the Democratic Republic of Congo WPD. The relative risks are not estimated in each setting due to insufficient context-specific literature for the various model parameters, but national level data is used to inform the model. This approach is consistent with conventional burden of disease analyses. WASH exposure factors include household access to water, sanitation, community sanitation coverage, and hygiene; susceptibility factors include whether the child in underweight, received vitamin A and Oral Rehydration Solution (ORS) in the case of diarrhea. Further details on the model can be found in appendix X.

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Chapter 5
WASH Service-Delivery Constraints and Potential Solutions

Key Points

- A new Water Law and an associated Water Policy (2015/16) provide momentum and a legal basis to address long-standing institutional weaknesses in the water, sanitation, and hygiene (WASH) sector of the Democratic Republic of Congo.
- In a context of state fragility and poor governance, three major institutional weaknesses have plagued the sector: institutional fragmentation, weak capacity, and a bias toward specific institutions and services. These general challenges have manifested differently across subsectors:
  - At national policy level, sector leadership has split between seven ministries, reducing the efficiency and coherence of policy making and implementation.
  - In urban water, the public utility (the National Urban Water Distribution Agency, [REGIDESO]) has struggled to reform, achieve cost recovery, and expand beyond its historic service centers. Alternative supply models have been slow to develop. Urban access has thus eroded overall and inequality between major and minor cities persisted.
  - In urban sanitation, a decades-long vicious cycle of weak, fragmented institutions and no investments has led to a lack of any public services for the rapidly growing urban population.
  - In rural WASH, institutional fragmentation and weak capacity has been partly compensated by a major, decade-long donor-financed program implemented by nongovernmental organizations (NGOs). To scale up and sustain its impact, however, more effective involvement of provincial governments will be needed.
  - A cross-cutting service gap arising from these institutional weaknesses has been widespread contamination of drinking water with fecal bacteria across urban and rural areas.
- The impact of the new Water Law and Policy on these institutional challenges is potentially profound:
  - A dedicated water ministry, regulator and re-ordering of the sanitation sector could decisively reduce fragmentation and provide stronger leadership on issues such as water quality.
  - The principle of at-cost tariffs could improve cost recovery at REGIDESO and other providers.

- Investments in marginal urban areas could be boosted by the law's support for decentralization, delegated management, and autonomous systems.
- Decentralization of responsibility for WASH could strengthen local government participation.

- The core challenge will be to maintain momentum and transform these opportunities into real change in the face of an entrenched sector structure and precarious political climate.

The Legal Framework: A New Water Law

For decades the Democratic Republic of Congo lacked a specific law governing the water and sanitation sector (Landu 2010, 22; WSP 2011b). This changed with the promulgation of the new Water Law on December 31, 2015. The new Water Law sets out a legal and institutional framework for the WASH sector in the Democratic Republic of Congo in line with the decentralizing thrust of the 2006 Constitution. Implementing the new Water Law will require broad-ranging and complex reforms to adapt the currently centralized, fragmented, biased, and ineffective institutional structure to its vision of a decentralized, coherent, and more evenly balanced WASH sector.

The Constitution outlines the distribution of responsibilities in the WASH sector. It assigns exclusive responsibility for national planning, the conservation of natural resources, and legislation on hygiene to the central government (Article 201, §33 and §36e/h). In contrast, the provinces are given exclusive responsibility for the organization of public services (Article 204, §10) and production of water (Article 204, §26). Overlap is introduced by shared responsibilities, which include the vaguely defined management of water and forests (Article 203, §16), hydrology programs (Article 203, §11) and the prevention of epidemics (Article 203, §17). Ultimately, the central government remains predominant as Article 205 renders null and void any provincial laws not in line with national legislation.

The new Water Law follows the Constitution's guidance by centralizing WASH policy making and regulation and decentralizing asset ownership and service provision. The law gives central government the power to set the national water policy (Articles 12 and 71), to regroup responsibilities for public water services under a single water ministry with wide-ranging powers over policy, standard setting, and financial support of rural water services (Article 15), as well as a regulatory authority to monitor norms and set tariffs (Article 75). Provincial governments, local authorities, or user associations are assigned the role of asset owner (Articles 72–73), are responsible for investments (Article 76) and required to delegate service provision to public or private entities (Article 78), which are to charge cost-based tariffs. These are major changes that will be difficult to implement as the sector has been notoriously fragmented, asset ownership and investment decisions have been concentrated in central agencies, such as the national utility REGIDESO, alternative providers have not been recognized, and below-cost provision has been the norm.

The Water Law does address the sanitation sector in 8 of its 126 Articles, confirming core principles, but leaving a detailed specification of responsibilities to a future ministerial decree. The law confirms the principles of decentralized asset ownership and delegated management for public sanitation (Article 96), and allows for a role of provincial and local governments. Yet the distribution of responsibilities is not detailed and no regulatory authority or single ministerial body is foreseen to give coherence to the fragmented subsector structure. At least, the potential for significant change is contained in the law, with Article 97 referring to a future ministerial decree to resolve these wide-ranging issues.

A National Water Policy has been drafted by the Ministry of Energy and Water Resources and aims to translate the provisions of the law into actionable policy.[1] The policy (*Politique Nationale du Service Public de l'Eau*, PNSPE) specifies the law's provisions, detailing the responsibilities at the various levels of government, recommending service options for urban, peri-urban, and rural areas, and outlining the future of sector agencies. The policy reiterates the unification of the water agenda in one ministry, foresees the transfer of the National Rural Water Service (SNHR) from the Ministry of Rural Development to the new Water Ministry, and calls for the assets of the urban utility REGIDESO to be transferred to the provinces, with the once monopolistic state utility becoming a delegated service provider "like any other" (MEWR 2016).

By contrast, the law's vagueness about sanitation is matched by uncertainty at the policy level. In 2013, the Directorate of Hygiene in the Ministry of Public Health (MPH) issued the National Sanitation Policy (PONA), and the Ministry of Environment, Conservation of Nature and Durable Development (MECNDD) issued the National Basic Sanitation and Hygiene Policy (PNHAB). While the former is ostensibly focused on collective and the latter on household sanitation, there are numerous overlaps (see table 5.5) and the two ministries are in a barely concealed rivalry. Neither of the policies has been implemented substantially in practice.

A major challenge confronting the water sector today is the practical implementation of the promising new law and policy in the face of an entrenched sector structure. In the sanitation sector, the new law is less clear about core issues such as the distribution of responsibility, thus not yet providing a clear basis for the reform of the sanitation sector. Ministerial decrees will be required to fill in the details.

The Present Institutional Structure and Its Major Weaknesses

The new Water Law's impact on the institutional structure is potentially profound. It could improve coherence and reduce fragmentation, creating one sector ministry, one regulator, and a clear distribution of responsibilities between central and decentralized levels, as well as providing guidance on the future role of key institutions such as the national utility REGIDESO.

Yet, to date, the law's provisions remain largely on paper and the institutional structure of the Democratic Republic of Congo's WASH sector continues to be characterized by three interlinked challenges: a strong degree of institutional fragmentation, major capacity gaps, especially at decentralized level, and a strong bias toward specific institutions and thus particular types of services. The delay in the law's implementation has been due not only to the size, complexity, and inertia of the Democratic Republic of Congo's vast state apparatus, but also the 2016 constitutional crisis of presidential succession that has diverted political energy away from ambitious reforms.

Institutional Fragmentation

The WASH sector remains highly fragmented, split between seven ministries, as well as the former state monopoly for urban water provision REGIDESO (table 5.1). This fragmentation reduces the efficiency and coherence of policy making and implementation by dividing related tasks over multiple ministries. For instance, overall water policy rests with the Ministry of Energy and Water Resources (MEWR), but rural water issues are still assigned to the Ministry of Rural Development, the urban utility is owned by the Ministry of Portfolio and operates largely independently, and sector coordination is formally led by the National WASH Action Committee (CNAEHA) within the Ministry of Planning. No single agency is in the position to monitor the evolution of the sector or to carry out capacity for overall sector planning and coordination

Not only are responsibilities divided, but in many cases, they are also not clearly defined or overlapping. For instance, broad responsibilities over the sanitation agenda are claimed by the

Table 5.1: National-Level Legal, Policy, and Institutional Framework of the Democratic Republic of Congo's Water and Sanitation Sector (Early 2017)

Aspect	Water		Sanitation	
	Urban	Rural	Urban	Rural
Legal framework	**Constitution of the Democratic republic of Congo** The 2006 Constitution, establishes the sovereignty of the Congolese state over water and sanitation (Article 9), the distribution of powers between the national and the provincial level (Articles 201—206), the right of Congolese citizens to health (Article 47) and drinking water (Article 48), and calls for the modalities to be defined by law.			
	The new Water Law (Loi°15/026) promulgated on December 31, 2015			
	The new Water Law has the following key provisions in the water sector: · A guarantee to all Congolese for just and equitable access to water resources (Article 5) · A single Ministerial attribution for water services · Decentralization of asset ownership and policy implementation (Articles 13, 70-72) · Delegated management: government is policy maker, asset owner, and regulator, but obliged to delegate WASH service provision to private or public entities (Articles 78-79) · Autonomous systems managed by user associations explicitly recognized (Articles 32 and 73) · Cost-based tariffs prescribed (Articles 84–85) · A new regulatory authority (Article 75)		The new Water Law briefly touches on sanitation in its Articles 90–97. National and provincial governments, and the executive arm of Decentralized Territorial Entities (ETDs), are assigned responsibility for organizing the removal and treatment of waste- and stormwater in agglomerations. Off-site individual solutions are endorsed for dispersed (rural) settlements, or cities without existing collective infrastructure. As with water services, government is given a regulatory and asset-ownership role, but prohibited from direct service provision, which may instead be delegated to public or private entities. A ministerial decree is yet to define precise responsibilities and norms under the Water Law. The Ministry of Public Health (MPH) and Ministry of Environment, Conservation, Water Forests and Tourism (MECNDD) have called for a dedicated Hygiene Code and Environment Law, respectively, but no progress toward either has been made.	
Policy Framework	**Second Poverty Reduction and Growth Strategy 2011–15 (DSCRP II)** This document outlines the overall growth strategy of the Government of the Congo, Dem. Rep.. Now slightly outdated, it is still a reference document. Water and sanitation are captured under the third of five pillars entitled "Improving access to basic social services and building human capital". The DSCRP II set specific targets for the urban and rural water sector, but not for sanitation.			
	"Politique Nationale du Service Public de l'Eau" (PNSPE) The national water policy has been drafted under the leadership of the Ministry of Energy and Water Resources (MEWR), but had not yet been approved by early 2017. The PNSPE details the implementation of the Water Law.		**National Basic Sanitation and Hygiene Policy (PNHAB), 2013** Issued by the Directorate of Hygiene (DH) in MPH. Scope covers urban and rural areas, though emphasis is on non-networked sanitation (*assainissement individual*) and focus is the rural environment. **National Sanitation Policy (PONA), 2013** Issued by the Sanitation Directorate (DAS) in MECNDD. Pro-poor focus on universal access. Demand-oriented approach based on awareness-raising campaigns. Focuses on communal sanitation and environmental management, rather than household-level sanitation. It had not been operationalized as of 2016.	

table continues next page

Table 5.1: Continued

Aspect	Water		Sanitation	
	Urban	Rural	Urban	Rural
State Institutions	**Ministry of Planning – National WASH Action Committee (CNAEHA):** Tasked with coordinating sector planning, investments, and strategy. In the process of restructuring and decentralization. (see appendix AA)			
	Ministry of Water (Foreseen in Water Law and PNSPE but not yet established)		**Ministry of Environment, Conservation of Nature and Durable Development (MECNDD), Directorate of Sanitation and Health (DAS):** Established in 2009, it has responsibility for aspects of safe disposal of excreta, wastewater, and stormwater management, solid waste management, water quality monitoring, and hygiene education. DAS is supposed to implement the PONA, but lacks the financial means and capacity to do so.	
	Regulator (Foreseen in Water Law and PNSPE but not yet established)			
	Ministry of Energy and Water Resources (MEWR): Formally in charge of water sector policy; positioning itself as the core of the new Water Ministry.		**Ministry of Public Health (MPH), Directorate of Hygiene (DH):** Has responsibility for household-level sanitation (e.g., use of latrines, household hygiene, etc.). Limited reach in urban areas, but clear institutional leader in rural sanitation due to its management of the major donor funded Villages et Ecoles Assaini (EVA) program, as part of which it also supports clean water interventions in rural areas.	
	Ministry of Portfolio, Committee for the Reform of Public Enterprises (COPIREP): Represents the state as owner of REGIDESO.	**Ministry of Rural Development - National Rural Water Service (SNHR):** Small-scale rural point source interventions.	**Ministry of Infrastructure, Public Works, and Reconstruction, Office of Roads and Drainage:** In principle responsible for road drainage and urban sanitation infrastructure, but not intervening significantly in the sanitation sector in practice.	
Service Providers	**REGIDESO:** Former state monopoly for urban water supply, now a commercial company but still fully state owned. Formally responsible for 97 cities, but 75 percent of revenue from just 3.	No national-level public or private service providers as such, but SNHR as well as the UNICEF/MPH EVA program (USD 350 million since 2008) have intervened across the Congo, Dem. Rep.	No public or private service providers in urban sanitation of significant scale.	No national-level public or private service providers as such, but the UNICEF/MPH EVA program ($350m since 2008) has promoted improved sanitation and handwashing across the Congo, Dem. Rep.

MECNDD as well as the MPH. Both ministries have issued sanitation policies that are formally distinct but effectively overlap, which is further complicated by the Ministry of Infrastructure which also has responsibility for urban drainage and sanitation infrastructure. Competition for scarce finance encourages duplication and lack of coordination as agencies strive to extend their funding sources, thus entrenching fragmentation.

Capacity Gaps

A second major challenge in the Democratic Republic of Congo's WASH sector are capacity gaps, especially at decentralized level. A 2011 report of the World Bank-administered Water and Sanitation Program (WSP) noted "the lack of capacity to effectively disburse funds and implement projects at scale" as the "key constraint" in the WASH sector. After decades of political conflict, lack of capacity has become a feature of the Democratic Republic of Congo's socioeconomic structure, affecting the WASH sector not only directly, but indirectly through a "lack of supporting infrastructure, logistics, and economic services" (WSP 2011a, 9).

Even long-standing, operationally minded institutions such as the public utility REGIDESO and National Rural Water Service (SNHR) "suffer from a serious shortage of qualified personnel" (UNEP 2011, 23). These sector capacity gaps are particularly grave in institutions that do not have WASH as primary focus (for example, MECNDD) and at the decentralized, provincial level. This is a critical problem as the Constitution and new Water Law shift important responsibilities, such as asset ownership and service delegation, to the decentralized level where underresourced and inexperienced local administrations struggle to cope.

The unfinished decentralization process has aggravated capacity gaps. The 2006 Constitution defined the Democratic Republic of Congo as a unitary, but decentralized state, and the number of provinces has increased from 11 to 26, yet the decentralization agenda remains incomplete (figure 5.1). Provincial revenues have consistently been below the constitutionally mandated share, and national ministries have continued to intervene directly at provincial level. Along with the weak institutional capacity and limited accountability of provincial authorities, this has contributed to impeding the delivery of basic services and diminished the benefits of decentralization.

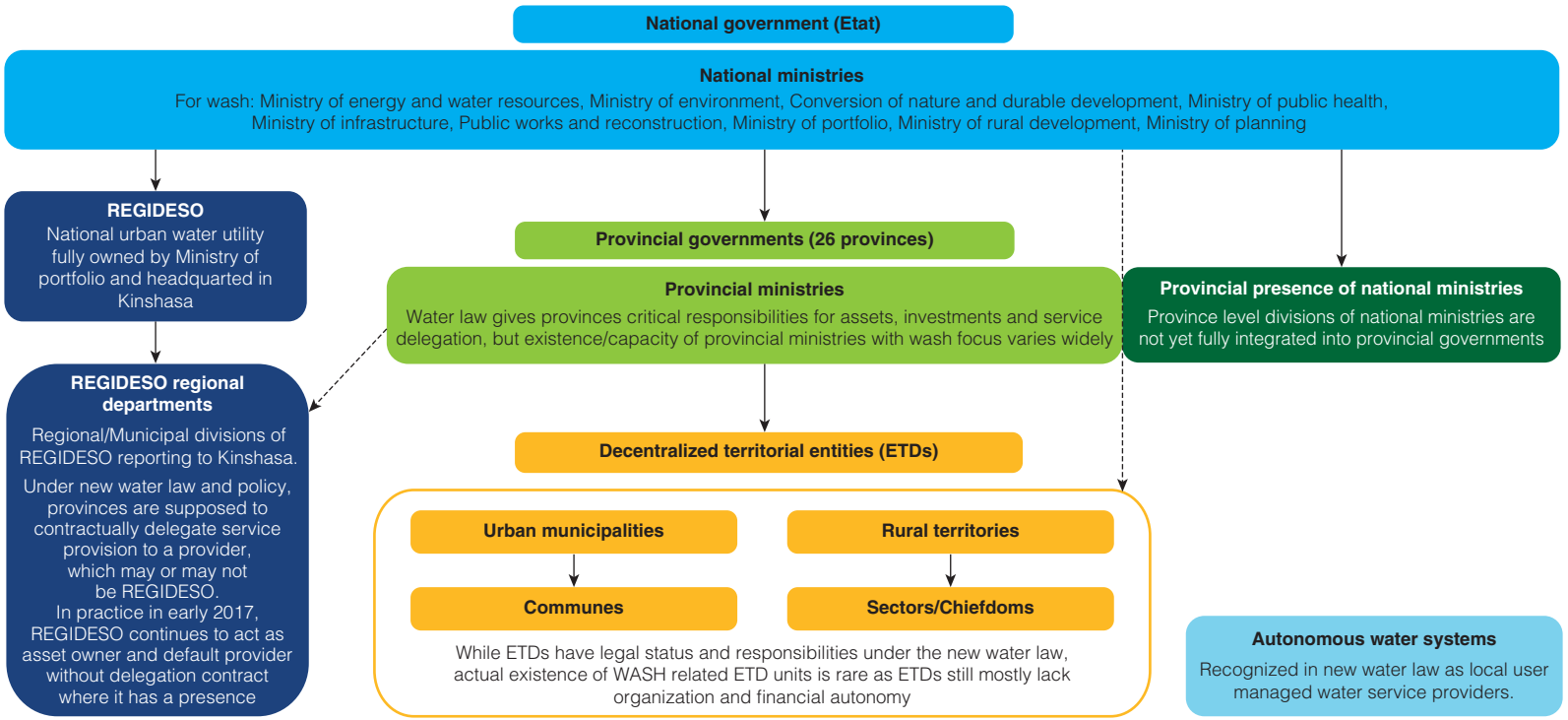
Capacity is particularly low in newly created provinces without established administrative centers. For instance, the new province of Tshuapa, which extends across a land-area three times the size of Switzerland, is to be administered from the new provincial capital Boende, situated in remote territory hundreds of kilometers from the previous province's capital. The creation of effective administrations in these new provincial capitals has not progressed far. As the PNSPE puts it, "today, few provinces and decentralized entities dispose of the technical and financial capacities to assume this role of managing the water needs of the population effectively" (MEWR 2016, 15).

Funding and Service Bias

The third major institutional challenge in the WASH sector is the strong bias of the limited availability of finance toward particular institutions and thus specific types of services. In an overall divided, underresourced, and low-capacity sector, investments have predominantly focused on just two institutional channels: the urban water utility REGIDESO and the "Healthy Schools and Villages" (*Ecoles et Villages Assainis* [EVA]) program, which is led by the United Nations Children's Fund (UNICEF) and the MPH. The vast majority of funds over the past decade has been absorbed by REGIDESO and the EVA program (figure 5.2).[2]

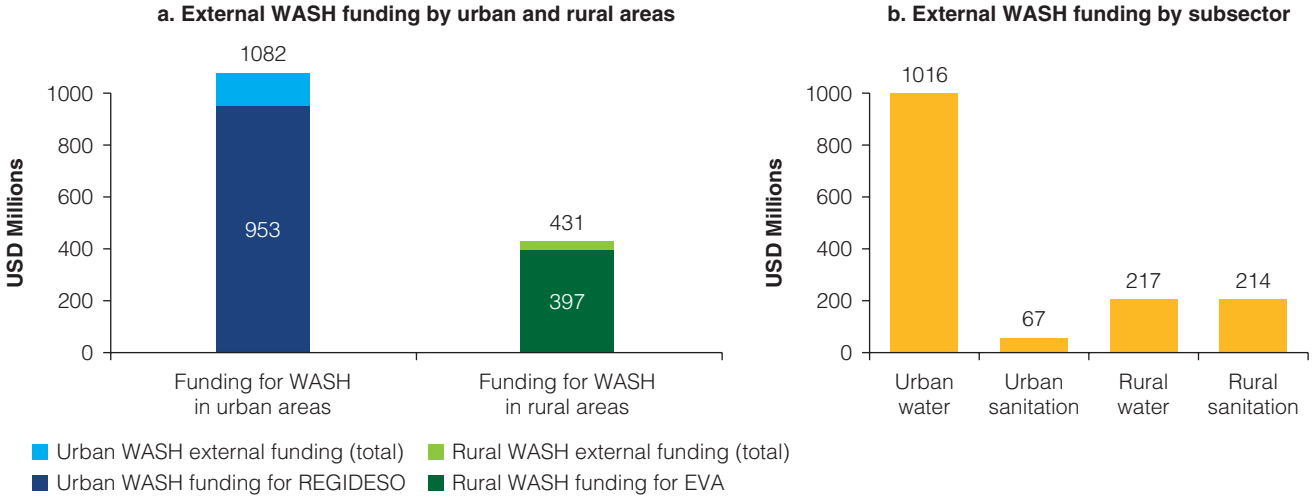
The concentration of funding has been driven by external financing. In the past, approximately 90 percent of sector investments have been externally funded (WSP 2011b, 21–31). In 2015, the government allocated USD 13 million to the sector (Ministère du Budget 2015) compared to approximately USD 85 million by donors.[3]

Figure 5.1: Overview of WASH Sector Hierarchies in Context of Partially Completed Decentralization



Note: REGIDESO = National Urban Water Distribution Agency. WASH = water, sanitation, and hygiene.

Figure 5.2: External Funding for WASH, by Urban or Rural Area and Subsector (Disbursements and Commitments, 2005–20)



Source: World Bank calculation.
Note: EVA = Ecoles et Villages Assainis (Healthy Schools and Villages Program). REGIDESO = National Urban Water Distribution Agency. WASH = water, sanitation, and hygiene.

Concentrating sparse funds in this manner has a strong justification: If a key problem is sector fragmentation and absorption capacity, and given almost universally high needs, the concentration of funding on established institutions and major cities can be seen as a rational choice of donors and policy makers seeking maximum impact by working with the relatively best-equipped counterparts in accessible locations.

A consequence of this strategy, however, is a focus on subsectors and geographic areas that are already better served, and a perpetuation of the weakness of disadvantaged institutions and service areas. The urban sanitation sector has particularly suffered from this self-reinforcing effect by which institutional weakness discourages funding, which in turn perpetuates institutional weakness. As figure 5.2 illustrates, minimal funding has been directed at urban sanitation even though improved sanitation access is less than half of improved water access in urban areas, and the public health threat at least as high as in rural areas.

Funding bias effects are also at play within subsectors and institutions. Most importantly, the strategy of the national water utility REGIDESO's has been to prioritize reform and the restoration of its financial position through a focus on its traditionally strongest service areas in Kinshasa, Lubumbashi, and Matadi, and within these centers, on richer, more central neighborhoods. In the capital, for instance, 48.7 percent of households in the central, well-off commune of Kinshasa have access to safely managed water (the top Sustainable Development Goal [SDG] tier) while only 1.2 percent in the poor commune of Kisenso do (WASH Poverty Diagnostic [WPD] survey 2016).

Governance and State Fragility

Weak governance is abetted by institutional fragmentation, capacity gaps, and service biases that disrupt accountability relationships, thus contributing to weak services, especially for the poor (World Bank 2004). Splintered sector institutions lead to diffuse responsibilities making it more difficult for citizens to effectively voice demands to the state. Providers that either enjoy near-monopolies (for example, traditionally REGIDESO) or are largely absent

(for example, in urban sanitation), tend to be difficult to call to account by clients or even policy makers. Capacity gaps further undermine providers' ability to act accountably.

WASH governance and thus services are also hampered by more general constraints associated with state fragility. As the World Development Report 2004 (*WDR*) noted, when "governments do not run well, they cannot sustain the institutional arrangements and accountability relationships that yield good services" (World Bank 2004). The Democratic Republic of Congo has suffered from a long history of colonial exploitation and post-colonial misrule during which "corruption and patronage became established as socially accepted cornerstones of the Congolese political tradition" (Matti 2010, 48). Corruption "remains widespread and is taking a heavy toll on public service capacity to deliver key services" (World Bank 2013). In Transparency International's Corruption Perception Index, the Democratic Republic of Congo was among the 20 worst performing countries in 2015. Even "at the central level, public institutions have been shattered by decades of neglect, mismanagement, corruption and war" (World Bank 2016c, 1). The development of institutions at decentralized level was inhibited because "the central government dominated the execution of power during both the colonial [period] and the second republic" (World Bank 2016c, 1).

The decentralization called for by the Water Law has the potential to bring sector agencies into closer proximity to the people they are meant to serve. This, however, would require that priority be given to developing and funding processes for effective and accountable local service provision, which are largely inexistent today, even if it may initially bring heightened implementation risks. A realistic approach to such reforms will have to take the political economy incentives of sector actors into account if it is to be successful (for example, competition for control of funding sources).

Governance and political economy issues loom over every aspect of the WASH sector. They are a key factor in the low performance and capacity gaps outlined above, as well as more specific problems, such as procurement risks and high overhead costs, that bedevil projects in the Democratic Republic of Congo. While there is no easy solution to the existing sociopolitical disincentives to effective collective action, addressing the underlying institutional-reform needs cannot be avoided. As the *WDR* put it, "if organizational failures are the result of deeper weaknesses in institutional arrangements […] direct attacks on the proximate determinants (more money, better training, more internal information) will fail" (World Bank 2004, 58).

Institutional fragmentation, capacity gaps, service biases, and governance are general challenges in the WASH sector, yet manifest differently across urban and rural areas and water and sanitation. The following sections will provide a more detailed subsector analysis to pinpoint service bottlenecks, especially for the poor, and then conclude by identifying possible next steps and recommendations.

Urban Water: In the Shadow of REGIDESO

The urban water sector in the Democratic Republic of Congo appears to have performed relatively well at first glance. Improved access is above 80 percent of the urban population and funding has been far in excess of finance available for the rural or sanitation sector (table 5.2).

Yet, a closer look reveals a more problematic picture. The total number of urban dwellers without access has been rising rapidly over the past decade, precipitated by rapid population growth. The quality of supply has stagnated at low levels or even deteriorated. As detailed in chapter 2, there has been a marked shift from piped on premises to less convenient public sources, and pollution of water with dangerous fecal matter is widespread. Urban access remains stratified by income and particularly by location, with Kinshasa and other major cities having better access than marginal urban areas.

Table 5.2: Urban Water Sector Overview Statistics

Improved Access in Urban Congo, Dem. Rep.			
Access Rate	Δ since 2000	Piped Access	Δ since 2000
81.1%	–3.7%	17%	–21.2%

Source: UNICEF and WHO 2015.

Improved Access in Urban Congo, Dem. Rep., by Socioeconomic Status and Location			
Urban Bottom40	Urban Top60	Kinshasa	Other Cities
79.2%	89.5%	96.9%	79.3%

Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2013–14.

Sub-Sector Funding	
Total 2005–20	$ per person in need of access by 2030
$1016m	$39

Source: World Bank calculation.

While the current urban population without improved access is below 5 million, over 25 million presently lack safely managed services targeted by the new SDGs, and taking into account expected urban growth, almost *50* million will require safely managed coverage by 2030 to reach the SDG universal access target.

These trends and inequalities are directly related to the institutional structure of the urban water sector. The former monopolistic urban water utility REGIDESO has continued to dominate the urban water subsector and has been the near exclusive recipient of investment funding over the past decade (figure 5.2). Yet, REGIDESO has struggled to achieve financial sustainability, keep up with demand in its core centers, *and* extend services to more marginal urban areas.

In the urban water sector, the funding and service bias resulting from the incomplete rehabilitation of REGIDESO is the most pressing institutional problem. While REGIDESO has successfully expanded access in core cities, the population has expanded even faster, service quality remains unsatisfactory and full cost recovery has remained elusive. The utility's strategy to prioritize investments in core cities to create profit centers that could then finance service expansion in more marginal urban areas has not yet succeeded and effectively created a structural bias against peri-urban zones and minor cities.

The new Water Law and SDGs are an opportunity to not only accelerate REGIDESO's reform, but to target underserved urban areas more directly through alternative investment channels. While investments centered on REGIDESO will remain critical to cover the rapidly growing population in Democratic Republic of Congo's major cities, the new Water Law has ended its monopoly and created a legal basis to work directly with provinces and alternative autonomous operators to target peri-urban areas and marginal cities more directly. Across approaches, however, it is clear that service quality and, in particular, the prevention of currently widespread water contamination must become a new priority across the entire urban sector.

The next subsection aims to give a concise overview of the historic context, institutional structure, and constraints in urban water, complemented by recommendations for next steps in the conclusion of this chapter.

Historical Context: The Rise and Decline of REGIDESO

Urban water supply in the Democratic Republic of Congo has long been dominated by the national utility REGIDESO. While it has lost its former monopoly, it remains the only public entity in the water sector with a national presence, structured organization, significant technical capacity, and the ability to generate large revenues. Its entrenched, yet weak, position explains many existing service biases and bottlenecks in urban water, and its future role under the new Water Law will be critical in determining whether the urban population, and the poor in particular, will benefit from improved services.

REGIDESO was established by Royal Order in 1933 by the colonial government. At the time, there were five existing urban water distribution stations in Congo. Expansion of the urban water supply began in earnest after World War II. In 1953, REGIDESO supplied 17 cities with 18 million cubic meters of water (Borgniez 1954, 3) and, by 1959, urban supply had been expanded to 48 cities, distributing 35 million cubic meters of drinking water annually along 3,700 kilometers of pipelines (de Raeve 1997, 328). After independence from Belgium in 1960, REGIDESO became a state-owned enterprise with a monopoly in urban water supply.[4] The company was operated in a strictly centralized manner, with all critical administrative, financial, and technical functions based in Kinshasa. By 1974, REGIDESO was supplying 55 urban centers and 125,000 private connections with water. During the early 1970s the company achieved a small surplus or broke even on its operations with government and donors financing capital investments (WHO and IBRD 1974).

In the 1980s REGIDESO continued to expand its services and was still considered one of the most successful African water utilities. The utility eventually supplied 94 out of the then 164 agglomerations above 5,000 inhabitants (Landu 2010, 22, 32). However, the accelerating decline of the Congolese economy and deterioration of the sociopolitical environment toward the end of the Mobutu regime in the 1990s, as well as the subsequent civil war, precipitated the downfall of the company.

In the wake of the Second Congo War in the early 2000s, 34 REGIDESO centers were fully out of service, and the performance of those still in operation had greatly deteriorated (World Bank 2008). Access to piped water in urban areas had halved from 1990, water production fell to 239 million cubic meters per year (versus a peak capacity of 375 million), non-revenue water rose to 39 percent, only 49 percent of bills issued were collected, and operating costs reached 166 percent of revenues (Kamanda 2009; Tribeche 2015, 15; World Bank 2008, 2–3).

REGIDESO's diminished financial performance was driven by an average tariff below production cost, overstaffing, high energy costs, fraud encouraged by weak controls and political interference, and the non-payment of water bills by state institutions. The latter accounted for 43 percent of REGIDESO's billings in the mid–2000s (World Bank 2008). The decline of REGIDESO occurred in a period of rapid population growth and urbanization, which heightened the service crisis. The population of Kinshasa alone rose from 1.5 million in 1975, to 3.6 million in 1990, 6.1 million in 2000, and 11.6 million in 2015 (UN 2014).

Institutional Constraints in Urban Water: REGIDESO's Difficult Reform and Structural Bias

The rehabilitation of REGIDESO has been at the center of efforts to improve urban water supply since the return of a fragile peace in 2003. Following a number of multi-sector emergency interventions that restored strategic parts of the existing piped water infrastructure, the World Bank took the lead in launching a comprehensive urban water sector reform and infrastructure investment project centered on REGIDESO, the so-called "Programme de Redressement." The International Development Association (IDA) of the World Bank Group supported this

endeavor with an original grant of USD 190 million in 2009, and additional financing of USD 166 million in 2016. Labeled Projet d'Alimentation en Eau Potable en Milieu Urbain (PEMU), it is the single biggest investment in the Democratic Republic of Congo's WASH sector today.

The PEMU project anticipated three phases to progressively extend water supply from the urban centers to the margins. The first phase aimed to restore REGIDESO's financial equilibrium through a private operator–driven internal reform combined with infrastructure investments focused on the three most established and profitable service centers (Kinshasa, Lubumbashi, and Matadi). To achieve profitability in these core centers, the reform aimed to improve revenue collection and reduce overstaffing.

It was planned that once financial equilibrium was restored, the second and third phases would expand service improvements to the next largest (Kisangani, Bukavu, Likasi) and finally all REGIDESO centers by 2020. More marginal centers would be rehabilitated "using cash generated in the profitable centers through a cross-subsidy" (World Bank 2008, 38). Eventually, the project foresaw that "in the medium to long term urban water supply services in the Democratic Republic of Congo will have to be decentralized and may eventually be entrusted to independent regional utilities" (World Bank 2008, 39). The project has since made progress in Phase 1, but failed to attain the more ambitious Phases 2 and 3.

Over the past seven years, this flagship reform program has had a positive impact on the utility and water services, in particular in the three core urban centers. Facilitated by major donor investments, a strong increase in active connections (+24.4 percent), water production (+29.9 percent), and metering rate (+20 percent) was achieved, as well as a cost recovery ratio that is now closer to break-even. The legal status of REGIDESO was changed from a state enterprise to a commercial firm in 2010. Though it remains fully owned by the Congolese state, key management positions were contracted out to a private firm in 2014 under a services contract that is linked to a performance contract with the government.

These improvements have come at a high cost, however, and key financial and performance targets have remained elusive. Project disbursements on hardware alone amounted to over USD 3,600 per connection made, over USD 630 per household member gaining access, and over USD 140 per beneficiary.[5]

As table 5.3 illustrates, the utility has also lagged on key financial and performance targets and continues to perform worse than its peers in the region. Non-revenue water has remained stubbornly above 40 percent and the bill collection rate around 70 percent, compared to project targets of 29 percent and 97 percent respectively. Moreover, despite the significant growth in water production, the population within REGIDESO's perimeter has grown faster still. The fact that REGIDESO has struggled to keep up with population growth is reflected in an over 20 percent decrease in piped on-premises access in urban areas since 2000 (UNICEF and WHO 2015).

Despite the reduction of staff per 1,000 connections, achieved largely through an expensive World Bank-financed retrenchment program, it remains far above its peers and, perversely, the cost of staff as a percentage of sales has gone up. This was largely due to "uncontrolled increases of the remaining staff's remuneration" at the very time that the utility was pursuing a financial turn-around (World Bank 2016b, 43). The retrenchment disproportionately affected technical supervisors and operational staff, and shifted the staff mix toward older, increasingly generously rewarded management (Tribeche 2015, 20).

REGIDESO's financial rehabilitation has also been undermined by the difficulty encountered in getting state institutions to pay official water bills. As of late 2015, public arrears amounted to close to CGF 85 billion (approximately USD 75 million). The refusal to pay public water bills is effectively subsidized by donor grants and creates a major gap in REGIDESO's finances as public institutions still constitute 22 percent of billings (World Bank 2016b). This is illustrative of the only partial political commitment to reforming REGIDESO, which is also reflected in the nature of

Table 5.3: REGIDESO Performance

	REGIDESO			African Average
	2006–8	2014–15	Change	(IBNET)
Cost Coverage	88%	93.7%	+5.7°%	101%
Bill Collection Rate	73%	70%	–3%	77.7%
Staff per 1000 Connections	17.7	14.3	–3.4	5
Staff Costs / Sales	35%	40%	+5%	-
NRW	45%	42%	–3%	28.6%
Active Connections (All Centers)	247,625	308,025	+24.4%	-
Metered Connections (%)	33%	53%	+20%	-
Population in Perimeter	24m	31.6m	+32%	-
Water Produced (million m3)	239	308	+29%	-
Liters/Person/Day (Produced)	27.3	26.8	–2%	-
Average Production Cost (USD/m3)	$0.81	$0.85	+4.9%	$0.54
Average Tariff (USD/m3)	$0.66	$0.75	+24.2%	-
Continuity of Supply (Hours/Day)	-	11	-	19.5

Source: REGIDESO 2015; Tribeche 2015; World Bank 2016b.
Note: IBNET = International Benchmarking Network for Water and Sanitation Utilities. NRW = non-revenue water. REGIDESO = National Urban Water Distribution Agency.

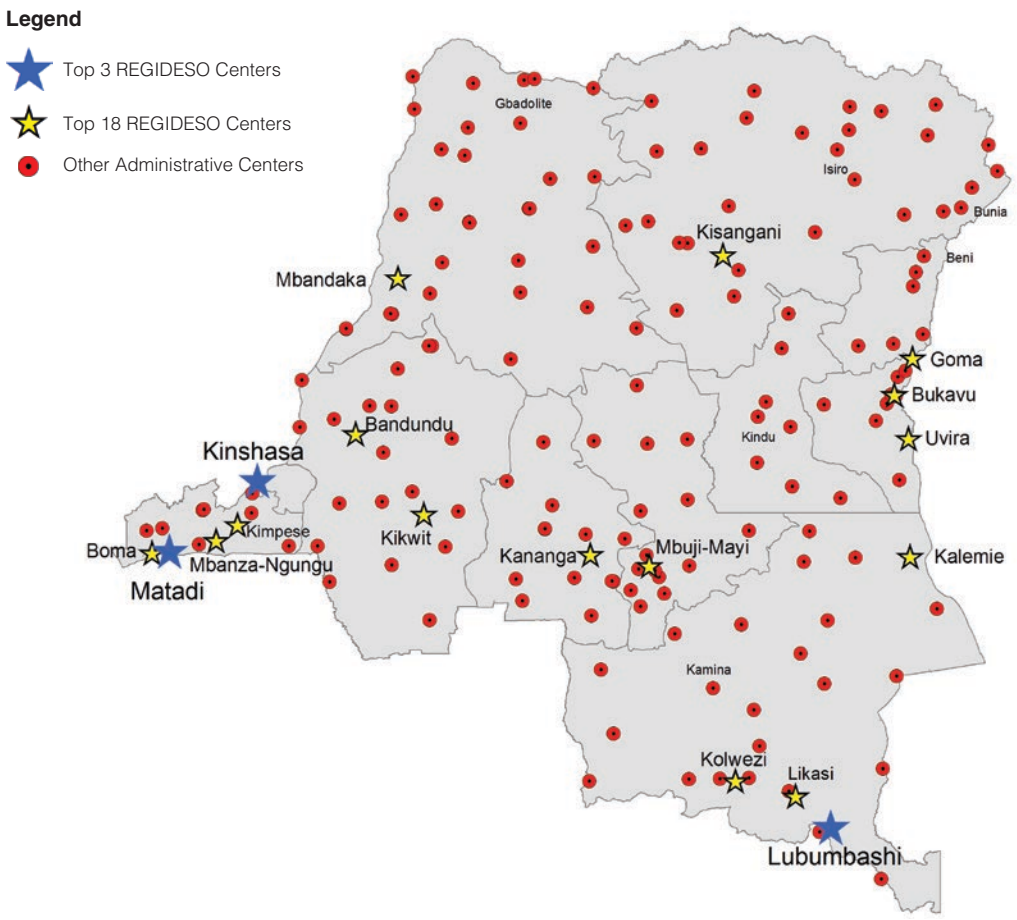
the services contract, which falls short of a full delegation and has left the operational direction of REGIDESO in the hands of political appointees with limited accountability (Tribeche 2015, 32).

Struggling to achieve financial viability and to keep up with population growth, REGIDESO has remained focused on its core centers, and the initial vision of a gradual expansion of investments to all 94 service centers and eventual creation of independent regional utilities has remained elusive. In fact, the administration of the utility has moved toward greater centralization with a recent consolidation of revenue and expenditure flows and associated disempowerment of provincial departments (World Bank 2016b, 43). While a complementary project financed by the Kreditanstalt für Wiederaufbau (KfW) has targeted secondary cities in selected provinces, it has struggled to win greater autonomy for provincial departments, and service provision and management attention has remained highly concentrated on major centers.

By 2014, out of now 97 formal REGIDESO centers, 60 percent of all sales points were located in just the "Top 3" REGIDESO cities of Kinshasa, Lubumbashi, and Matadi, generating 75 percent of revenues. The "Top 18" centers, shown in map 5.1, generated 95 percent of sales (REGIDESO 2015). As the map illustrates by displaying other administrative centers in the country, this service concentration bypasses urban water supply in many of the more marginal towns of the Democratic Republic of Congo, thus leading to the access differentiation in urban areas. Moreover, even within its major centers, REGIDESO services tend to be concentrated in wealthier districts in line with the historical location of its infrastructure and its revenue maximization strategy. In Kinshasa, the WPD survey showed REGIDESO access above 90 percent in core communes such as Kinshasa, Makala, and N'Djili, but barely 50 percent in poor communes, such as Kisenso.

The concentration of funding on REGIDESO highlighted in figure 5.2 has been important to restoring and improving services in rapidly growing major cities, but the strategy of coupling improvements in core cities to service amelioration in the decentralized provinces and marginal urban areas has not come to fruition. REGIDESO has retained a highly centralized administration and structural bias toward major centers, and even within these has been slow to expand

Map 5.1: Top 3 REGIDESO Water Supply Centers (95 Percent of Sales) and Other Administrative Centers



Source: REGIDESO 2015.
Note: REGIDESO = National Urban Water Distribution Agency.

services to poorer peri-urban areas in line with its revenue maximization strategy. The almost exclusive concentration of finance on REGIDESO has thus also entrenched service inequalities in urban water.

Service inequalities related to the REGIDESO's strategic priorities have been reinforced by operational decisions. REGIDESO's tariff schedule, for instance, has been regressive as the average price of water from standposts was up to four times more expensive than for private connections (FINAGESTION 2014, 11; REGIDESO 2015, 5) and initial connection costs have been high. Laudable attempts to expand standposts have not yet reached significant scale. In 2014 there were only 1,600 functional REGIDESO standposts across the country and fewer than 100 in Kinshasa (Tsitsikalis and Prie 2014). There is presently no coherent standpost strategy across REGIDESO centers and, in many cases, household connections are converted to public standposts to increase short-term revenues.

REGIDESO has started to address some of these challenges. In particular, the utility has committed to a progressive tariff reform and incipient social connections program. Ultimately, however, such operational measures can only improve services where REGIDESO has an operational presence. As long as its structural service bias toward major cities persists, more comprehensive, pro-poor services will be constrained.

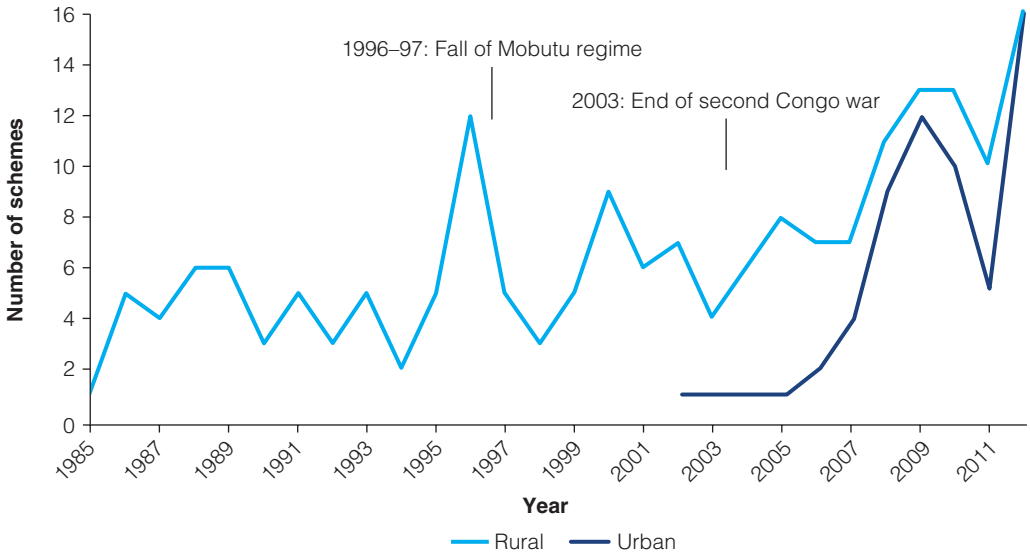
While investments through REGIDESO will remain critical to cover the rapidly growing urban populations in major centers, these investments need to be complemented by alternative approaches where REGIDESO does not reach effectively. After a decade of focusing almost solely on major centers and the failure to achieve the original vision of a decentralized REGIDESO, complementary investment channels are needed to help correct structural service gaps. The new Water Law has created the legal basis for such complementary approaches by shifting asset ownership and responsibility for service delegation to provinces, and allowing the possibility of third-party private, public, or user-managed operators.

The Rise of Autonomous Water Supply Schemes: A Pro-Poor Alternative?

As REGIDESO has struggled to extend services over the past decades, autonomous water supply schemes have risen to become a critical part of the Democratic Republic of Congo's urban water infrastructure, in particular for the poor in peri-urban areas, small towns, and densely populated rural areas. Independently run piped systems today meet the needs of millions of Congolese in the gap REGIDESO has left, and which point-sources and other alternatives could not fill. As figure 5.3 illustrates, the rise of urban autonomous schemes appears to have coincided with the surge in demand during the period of REGIDESO's decline and rapid urbanization since the fall of the Mobutu regime in the late 1990s.

By late 2014, some 520 autonomous networks existed in the Democratic Republic of Congo, of which approximately 80 serve urban households in peri-urban expansion zones of cities (Tsitsikalis 2014, 21). Urban schemes have been expanding particularly rapidly since 2007, funded by external partners and supported by local NGOs. In Kinshasa alone, more than 40 autonomous schemes today supply an estimated 500,000 people with water, a number expected to double by 2018 through an investment program financed by the French Development Agency (Bédécarrats 2016).

Figure 5.3: Number of Autonomous Water Supply Schemes Built in the Democratic Republic of Congo



Source: Water and Sanitation Program (WSP) and GRET Study of Autonomous Water Systems in the Congo, Dem. Rep.
Note: Construction date data was available for 67 percent of surveyed (peri)urban schemes.

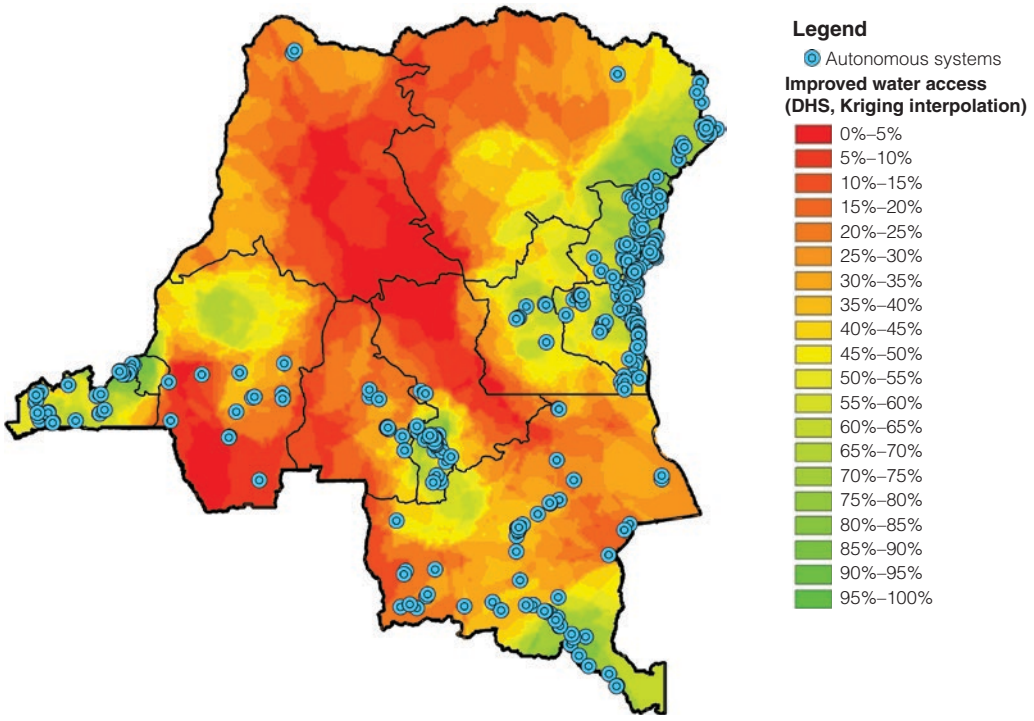
Autonomous schemes are important pro-poor suppliers of water in urban areas, because they have been disproportionately set up in impoverished peripheral neighborhoods that lack REGIDESO supply. Prices tend to be higher than REGIDESO, but lower than available alternatives, such as bottled water. In Kinshasa, the cubic meter price in autonomous schemes is approximately USD 2.1 per cubic meter compared to USD 0.35 per cubic meter for REGIDESO private subscribers and USD 1.54 per cubic meter for the small number of REGIDESO standpipes (Bédécarrats 2016, 10).

These prices generally allow autonomous schemes to achieve full cost recovery (Bédécarrats 2016, 10). By contrast, REGIDESO sells to private consumers at a loss (FINAGESTION 2014), which contributes to its structural deficit, low-quality service, and inability to reach more of the steadily growing urban consumer base. Moreover, the typical model of discrete per-volume pricing at standposts also suits many poor households with limited and unstable incomes better than REGIDESO's model of monthly bills.

Autonomous schemes are particularly common in Eastern Congo, and in the peri-urban areas of large agglomerations such as Kinshasa, Lubumbashi-Likasi and Mbuji-Mayi (map 5.2). While in mountainous Eastern Congo, rural gravity schemes providing unmetered water to private connections are predominant, the (peri-) urban schemes of southern, central, and western Democratic Republic of Congo have different characteristics.

Typically, peri-urban schemes "operate with a 100–150m deep borehole […] a generator-powered submersible pump, an elevated reservoir, offices and distribution pipes supplying from 10 to 45 standpipes as well as connections for schools and health centers. Each system is designed to supply from 10,000 to as many as 40,000 people" (Bédécarrats 2016, 2).

Map 5.2: Location of Autonomous Schemes and Estimated Distribution of Improved Water Access, 2014



Sources: Tsitsikalis 2014; Demographic and Health Survey (Enquête Démographique et de Santé) 2014.
Note: DHS = Demographic and Health Survey.

One reason for the growth of autonomous schemes is relatively low investment costs, which have been estimated at approximately USD 35–50 per beneficiary compared to over USD 140 in recent REGIDESO projects. However, services offered by urban autonomous schemes are typically more limited. As peri-urban schemes primarily supply via standposts, average consumption has been estimated at just 6 liters per capita per day.

The majority of autonomous systems (more than 80 percent) are administered by local community structures (Tsitsikalis 2014). In peri-urban areas, a popular model has been dubbed "ASUREP" (in French, *Association des Usagers des Réseaux d'Eau Potable*; in English, the Users Association of Drinking Water Networks). Each ASUREP administers one piped scheme and is an independent non-profit organization under Congolese law. Strong local ownership is achieved by an elected general assembly that oversees an elected board, which in turn recruits a management team locally. The ASUREPs are organized in an incipient federation (Fédération des associations des réseaux d'eau potable, FEDASU), which aims to represent the ASUREP's interests and provide technical support services. At present, however, primary technical assistance is still provided by the (externally funded) NGO, Action Développement et Intégration Régionale (ADIR) in the cities of Kinshasa and Mbuji-Mayi. It has had a key role in setting up ASUREPs, monitoring their performance, and intervening directly, if necessary. A similar role has been played by other NGOs across the country.

While this autonomous system model has been locally successful, challenges remain. First, upfront investment costs and crucial technical support through NGOs, such as ADIR and others, remain reliant on external support. While this is typical for the Democratic Republic of Congo's water sector as a whole, it does raise the question of how the model could be scaled up and how sustainable it will be.

A second issue is the relatively high running costs that arise from expensive energy and the lack of economies of scale. This is problematic as it may make the ASUREP model less suitable in areas of the country that are poorer than Kinshasa, and lack its high, accessible water table. While 9 out of 13 autonomous schemes constructed five years ago by the Belgian Development Assistance in South Kivu and Maniema are still functional (CTB/DGCD 2016), a DfID funded autonomous systems pilot in Mbuji-Mayi was considered a failure with only 4 of 11 systems functioning at the point of project closure (DfID 2012).

A final risk to autonomous schemes is their relationship to REGIDESO. The legal recognition of the autonomous systems in the new Water Law was a big step toward safeguarding autonomous systems from asset expropriation and state predation. Even so, and though many autonomous schemes are currently serving areas in which REGIDESO has no effective presence, if both ASUREPs and REGIDESO "continue to extend their service areas, they will increasingly find themselves in competition" (Bédécarrats 2016, 12). This may put ASUREPs in a difficult position, especially as REGIDESO continues to price its water below cost.

Competition is not inevitable, however, and a fully autonomous role of these small systems may only be transitional. These "two actors could find a common interest in collaborating [for instance,] the ASUREPs could purchase water wholesale from REGIDESO and distribute it in areas where they are more efficient" (Bédécarrats 2016, 12). As citywide networks expand, coordination will become critical. To date, however, a strategic plan or explicit agreements are lacking.

In spite of these unresolved challenges, peri-urban autonomous schemes have been a pro-poor success story in urban water supply of the Democratic Republic of Congo. They provide a low cost solution to basic water supply when citywide infrastructure is not financially or technically feasible. This makes them particularly suitable for small towns or peri-urban areas that are not reached by existing networks. The key challenge will be to successfully extend this model beyond the present core areas, to make the support organizations less dependent on external financing, and to coordinate investments into autonomous schemes with larger-scale suppliers, in particular REGIDESO, to avoid duplication and conflict.

Implications for Pro-Poor Services in Urban Water

Inequalities of improved urban water access in the Democratic Republic of Congo are not primarily within, but between major and marginal urban areas. Most urban poor without access live on the margins of large centers and in smaller cities. The primary challenge for pro-poor water services is thus to correct the structural bias, which is a direct consequence of REGIDESO's historic focus on major centers, and the traditional weakness of alternative urban supply models due to its past monopoly. The partial success of REGIDESO's reform since 2008 has fallen short of financial sustainability and a decentralized service expansion to smaller cities. The rise of autonomous schemes has been encouraging, though still lacks scale.

A systematic improvement of services for the poor is thus not simply a matter of evolutionary operational fixes, more structural changes are necessary. Operational improvements at REGIDESO, such as standpost construction, tariff adjustments (for example, to bring standpost tariffs below those of household connections and end the presently regressive cross-subsidies), gradual expansion of existing networks, and service quality improvements of course continue to matter in light of the new SDG targets and fast urban growth in core REGIDESO centers. Yet to reach the poor in marginal urban areas, a new push for decentralized, alternative investments is necessary. The achievement of the Water Law is that it creates a legal basis for decentralized supply, opening complementary financing channels through provincial counterparts and third-party operators. This allows more direct investments in marginal areas that REGIDESO is not reaching.

Urban Sanitation: Where to Begin?

Urban sanitation is the WASH subsector with the lowest improved access, the weakest institutional structure, and the least funding. Even optimistic estimates put the urban access to improved sanitation rate in the Democratic Republic of Congo at a mere 28.5 percent and show a decline since 2000 (table 5.4) (UNICEF and WHO 2015). In the absence of systematic interventions, the absolute number of urban dwellers lacking improved sanitation has risen dramatically from barely 6 million in 1975 to over 30 million today. This is expected to double again by 2035. Poorer households tend to have worse access, but access to safe facilities is low even for the top 60 percent. Access to safely managed sanitation targeted by the SDGs is below 4 percent, as very few households have improved private toilets with handwashing facilities and safe disposal of feces. This is nothing less than a public health crisis, reflected in high rates of diarrhea and malnutrition among urban children.

Table 5.4: Urban Sanitation Overview Statistics

Improved Access in Urban Congo, Dem. Rep.			
Access Rate	Δ since 2000	Open Defecation	Δ since 2000
28.5%	−1.0%	2.5%	−1.0%

Source: UNICEF and WHO 2015.

Improved Access in Urban Congo, Dem. Rep., by Socioeconomic Status and Location			
Urban Bottom40	Urban Top60	Kinshasa	Other Cities
23.7%	38.3%	20.7%	25.8%

Source: Demographic and Health Survey (Enquête Démographique et de Santé) 2013–14.

Sub-Sector Funding	
Total 2005-20	$ per person in need of access by 2030
$46m	$1

Source: World Bank calculation.

Funding for urban sanitation has remained minimal. Total disbursed and committed financing has been less than USD 50 million for the period 2005–20, 20 times lower than in urban water. Many factors have conspired to lead to this outcome: the lack of sector policy leadership, the absence of institutions capable of planning and absorbing investments effectively at the local level, the hidden impact of poor sanitation which limits political pressure and facilitates collective inaction, the paralyzing scale of needs and the complexity of Democratic Republic of Congo's urban areas that range from semi-rural towns to the megapolis Kinshasa. The dominant question in urban sanitation is thus: where to begin?

The subsector has been trapped in an informal, low-outcome equilibrium unable to overcome the collective action problem of poor sanitation. It will require public efforts to initiate new solutions. While a comprehensive solution to the urban sanitation problem in the Democratic Republic of Congo is unlikely in the medium term, it is critical to lay a foundation for larger-scale action at the city level by resolving the prevailing institutional confusion and by breaking with decades of public inaction with well-defined, replicable pilots focused on priority areas. Such pilots should improve the sanitation service chain to achieve significant local impact. At this stage, on-site sanitation will remain dominant. Piped sewerage may be viable only for the densest central areas and would have to overcome high costs and limited OandM capacity even there.

The most suitable public counterpart in the Democratic Republic of Congo to implement locally appropriate and demand-responsive sanitation solutions is the municipal level, which is currently largely inactive in urban sanitation. Existing policies and the new Water Law provide a basis for a decentralized approach and service delegation (Articles 90–96). A ministerial decree may further specify responsibilities and standards as foreseen in the law.

At the start of a renewed effort in urban sanitation, the focus should be on the largest cities. It is there that negative externalities of poor sanitation are highest, where synergistic effects with existing improved water access can be realized, and where economies of scale may allow a role for commercial actors.

This subsection aims to give a concise overview of the history and institutional constraints in urban sanitation, complemented by specific recommendations in the conclusion to break with decades of neglect.

Historical Context: A Century of Inaction

Urban sanitation has been a neglected problem since colonial times. In 1927, a report by the Belgian government cited hygiene and sanitation in urban areas among the biggest public health challenges in the colony behind only the fight against sleeping sickness (see also appendix Z), pointing out that:

> *Hygiene in cities and stations has always been the most neglected problem in the colony. The reason can be found in a lack of qualified staff dedicated to planning and implementing [sanitation] infrastructure, the lack of coordination between responsible institutions and absence of hygiene awareness*. (Royaume de Belgique 1928, 28, 30)

While the colonial government eventually built some sewerage and drainage infrastructure, it remained limited to the centers of major cities and began to fall into disrepair after independence. In 1974, a World Bank report highlighted the decay, inaction, and regression in the urban sanitation sector:

> *Sewers have not been properly maintained for the last decade and the few treatment plants in existence no longer function […] The institutional situation in sewerage […] is far from clear […] there are no institutions comparable with REGIDESO […] In the absence of adequate institutions there are no development plans for sewerage*. (WHO and IBRD 1974 iii, 3, 6)

The national water utility REGIDESO never took a significant role in urban sanitation. Even though REGIDESO was judged to be a "strong candidate to take charge of sewerage in the long term" (WHO and IBRD 1974), this never occurred due to financial constraints and the utility's pre-occupation with water. Instead, the same set of challenges persisted, as a WHO report noted a decade later in the early 1980s:

> *In contrast to urban water supply, the other subsectors have practically not developed during the past decade […] immediate measures [are] particularly necessary in the urban sanitation subsector […] other than the lack of resources, the major constraint to the development of urban sanitation seems to be the near total absence of an institutional framework*. (WHO 1982, 6)

The establishment of the Sanitation Directorate (DAS) in the early 1980s, now within the MECNDD, created a national institution formally responsible for the hygienic disposal of excreta and wastewater. However, DAS has been underfunded since its inception and its actions largely limited to small-scale interventions with little lasting impact (WSP 2011b, 14). The Sanitation Directorate has also remained a marginal concern in a ministry primarily occupied with the country's vast forestry resources and in administrative competition with other state institutions such as the MPH.

In 2006, a World Bank-financed study once more noted the "badly organized and unsuitable institutional framework," "weakness of financial flows," and "lack of capacity" (IGIP 2006), and to date little progress has been made. The latest restatement of the unchanging challenges of urban sanitation has come in the sanitation policy DAS itself released in 2013:

> *Lack of political prioritisation and lack of an adequate legal and institutional framework, alongside weaknesses in basic infrastructure and inadequate financing, make the sanitation sector one of the lowest performing in the* [*Democratic Republic of Congo*]. (MECNDD 2013, 6)

For a century, while the population of Democratic Republic of Congo's cities rose by the tens of millions, a circular problem prevented progress in urban sanitation: without a capable institutional framework, infrastructure could not be financed and maintained; but without financing, institutions could not arise and take meaningful action.

Institutional Constraints in Urban Sanitation: Policy Confusion and the Implementation Gap

The urban sanitation portfolio at national level is split between competing ministries leading to confusion in overall planning, regulation, and sector leadership, and lacks implementation capacity. From a policy perspective, the unification of planning and supervision tasks in one national public sanitation service is a priority. In terms of service delivery, municipalities have increasingly been identified as responsible for infrastructure construction, asset ownership, and service delegation, yet have not assumed these roles in practice in any major city of the Democratic Republic of Congo. The municipal role should be confirmed and meaningfully realized through city-based and -owned pilot interventions in priority urban areas.

At policy level, the main institutional overlap is between the Directorate of Sanitation (DAS) in the Ministry of Environment (MECNDD) and the Directorate of Hygiene in the MPH. The two agencies have issued competing national policies aiming to place their institution at the center of sector leadership (table 5.5). While the practical focus of the MPH remains on rural sanitation, where it wields significant resources through the EVA program, its involvement confuses sector actors and prevents clear strategic leadership. Institutional overlap is replicated at provincial level with horizontal overlaps between provincial divisions of environment and public health, which are further complicated by lack of clarity about vertical lines of accountability as provincial divisions sometimes report to the provincial and sometimes to the national minister.

Table 5.5: Areas of Overlap between Sanitation Sector Policies

	PONA (MECNDD 2013, 11)	PNHAB (MPH 2016, 10)
Overlaps	Wastewater (domestic and industrial) and human excreta/ fecal sludge	Wastewater (domestic only) and human excreta (domestic and collective)
	Special/dangerous waste (industrial, hospital, etc.)	Special waste (biomedical, etc.)
	Vector control	Vector control
	Solid waste (domestic and industrial)	Solid waste (domestic)
Only in PONA	Stormwater	
	Water Resource Protection	
Only in PNHAB		Basic Hygiene (personal hygiene, food hygiene, etc.)

Sources: MECNDD 2013; MPH 2016.
Note: PHHAB = National Sanitation and Hygiene Policy. PONA = National Sanitation Policy.

There is more consensus on the principle that municipalities ought to be responsible for infrastructure implementation and service delegation, though it remains largely theoretical. Under both the MECNDD's PONA and MPH's PNHAB, the municipal level has primary responsibility for urban infrastructure construction and service delegation. The new Water Law also supports, though does not prescribe, municipal institutions as implementing agencies, and mandates the separation of asset ownership and service provision. Unfortunately, there appear to be no municipal authorities in the Democratic Republic of Congo that have actually implemented sanitation infrastructure or supported service provision at significant scale yet.

The creation of capable municipal institutions is of particular importance in the Democratic Republic of Congo, because urban sanitation has historically not fallen into the remit of the urban water utility REGIDESO. Considering its new commercial mandate and focus on achieving cost recovery, REGIDESO is not positioned to build up sanitation services that would likely require subsidies for a considerable time. Moreover, REGIDESO's centralized administrative structure would be ill-suited to deliver sanitation services outside a few cities.

In terms of the institutional framework, there are thus clear opportunities for improvement. Harmonizing the two competing policies and consolidating institutional leadership in one national public sanitation service could reduce inertia and conflict at national and provincial levels. In terms of service delivery, the new law and policies support a key role for municipal agencies, but these need to be built up as well as given budget and responsibility to realize concrete interventions.

Addressing the Entire Urban Sanitation Service Chain

The new SDGs shift focus from a single-minded concern about containment of fecal matter in toilet facilities, to a more comprehensive approach that aims for a safe sanitation service chain from initial containment to safe disposal. The sanitation service chain (figure 5.4) starts with the initial separation and containment of fecal matter from human contact. Under the 2015 MDGs, hygienic separation was the ultimate target and defining characteristic of improved toilets. As detailed in chapter 2, barely a quarter of the urban population have improved facilities table 5.4, and less than 17 percent of the B40 by asset wealth. This appears driven by the high cost of improved latrines, which have been estimated at USD 300–400 for a simple pour-flush

Figure 5.4: Sanitation Service Chain

pit latrine for a household in urban Democratic Republic of Congo and as high as USD 1,400 for a septic tank (Hutton and Varughese 2016).

Even the first step of hygienic separation of feces from human contact is thus a financial stretch for most Congolese. However, the more stringent SDGs also require its safe management after this initial separation. Unless possible on-site, this requires safe emptying, transport, treatment, and disposal of fecal matter.

In dense urban areas, there is no space for consistent and universal on-site containment, and the organization of a safe off-site service chain has so far failed due to inaction of the public sector. In urban Democratic Republic of Congo, piped sewer systems for off-site treatment are virtually unknown. Over 95 percent of the urban population use facilities that first contain fecal matter on-site in a pit (82 percent) or septic tank (13 percent). Safe management of these sites would require a secure covering of filled pits or their safe emptying and disposal, which is relatively uncommon. Poor urban households generally construct latrines themselves or use informal masons, leading to low-quality pits. In combination with lack of space and often low groundwater, this creates poor conditions for safe on-site containment in urban Democratic Republic of Congo. Latrine contents often discharge into their surroundings, in the absence of any attempt to empty and safely dispose fecal matter (OPM 2016).

Demand for professional emptying services is low due to high cost and results in uncontrolled discharge. In Kinshasa, the cost of mechanical emptying with trucks is approximately USD 100, while manual emptying costs are approximately USD 50. In a survey carried out by the WPD in Kinshasa, a third of households with septic tanks and nearly two-thirds with unimproved pits have not emptied these in the past five years. When emptying was done, over 65 percent of households did so manually.

Even when emptying takes place, it does not solve, but merely displaces, the public health problem, as there are no formal sites for the safe disposal of fecal sludge. A review of six of the largest cities in the Democratic Republic of Congo (Kinshasa, Lubumbashi, Mbuji-Mayi, Kananga, Bukavu, and Kindu) revealed no functional treatment plants nor even formal, safe disposal sites. Instead, the excrement of millions is dumped without supervision into the open ground or water bodies in and around cities (OPM 2016). Past urban sanitation interventions were minor subcomponents in water-focused projects and were generally limited to dispersed public latrine systems with no clear link to municipal agencies or disposal options. This did not address systematic weaknesses in the sanitation service chain and had no lasting impact.

The weak sanitation service chain is marked by a set of interlocking constraints that contribute to a collective action problem. While the public as a whole would greatly benefit from a safe service chain, the costs are too high to be borne individually at every step, and potential benefits are undermined by gaps further down the chain. The problem of safe disposal illustrates this: without controlled, safe, and accessible disposal sites, uncontrolled dumping of fecal matter will continue unabated in Congolese cities. Yet designation of such sites requires public action and cannot be undertaken at individual level, and indeed, has even been opposed locally. Emptying and transport services remain sporadic and geared toward wealthier households. Without safe disposal sites, this merely shifts the public health problem rather than solving it. Similarly, even when households invest in hygienic toilet facilities and emptying, these benefits are undermined if others continue to dump fecal matter into the shared environment.

The lack of effective collective action is a direct result of the absence of capable institutions and financing, facilitated by low attributability and diminished expectations. Amid a host of other problems, public demand for sanitation improvements is low as the negative externalities are not as visible as, for instance, those of solid waste. Nor are there recent examples of successful public interventions to set expectations.

Implications for Pro-Poor Services in Urban Sanitation

The poorest suffer most from collective action problems across the sanitation service chain as they lack the means to privately compensate for the lack of public interventions. In urban sanitation, the cost of a septic tank is approximately three times the current per capita GDP of the Democratic Republic of Congo (Hutton and Varughese 2016). Even if poor households invest in expensive on-site solutions, they remain at higher risk off cross-contamination in their poorer, denser, and less controlled neighborhoods. Other vulnerabilities associated with poverty, such as food scarcity and lack of medical care compound the risks of exposure to unsafe WASH facilities.

Municipal institutions able to take significant collective action must emerge if urban sanitation services for the poor are to be improved. Given the lack of space for safe confinement, private on-site facilities are not a feasible approach, even if high-quality latrines were widely affordable. Traditional, citywide sewer systems are also not realistic in the medium term. At best incipient municipal sanitation agencies cannot absorb investments of such complexity, and would lack the capacity for operations and maintenance.

A gradual approach focused on discrete, practical, pro-poor interventions along the entire service chain is thus advisable. Options include the construction of safe disposal sites, the professionalization of emptying services, support to developing lower-cost latrines, construction of local decentralized condominium sewer systems and point-of-use water treatment to fight fecal contamination directly. Such incremental steps are more realistic, yet could have quantifiable local impact and start a cycle of institutional and service improvement. Box 5.1 details the case of Kinshasa, which illustrates many of these issues.

Box 5.1: Urban Sanitation in Kinshasa: A Case Study

Map B 5.1.1 provides an overview of the known distribution of sanitation technologies in Kinshasa.

Access: The colonial sewer system in central Kinshasa has been dysfunctional for decades. Today the majority of the capital's population relies on shared, low-quality latrines. While outright open defecation is low (2 percent), only 21 percent of *Kinois* have access to unshared improved toilets. Of these, less than 7 percent also have handwashing facilities as targeted by the new SDGs. Worryingly, even fecal matter from improved facilities is generally not disposed of safely due to the weak sanitation service chain.

Containment: Even improved latrines are typically of low quality with fecal matter seeping into the ground or water bodies (CNAEA et al. 2015). In the WPD survey of seven communes in Kinshasa, over 38 percent of households had never emptied their pit, letting it overflow or moving location when it was full.

box continues next page

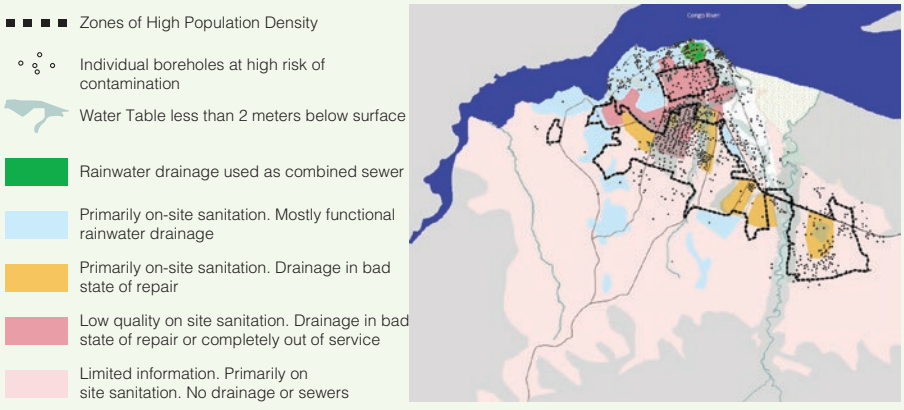
Box 5.1: Continued

Emptying and transport: The dangers of unsafe containment are heightened by the limited availability of professional emptying services. There are no public trucks in service. Private mechanical emptying services are small scale and expensive (approximately 10 companies with 2–5 trucks each). Emptying costs are relatively high with even individual manual emptiers charging between USD 50–100.

Treatment and Disposal: Kinshasa does not have any safe disposal or treatment sites. Trucks dump sludge at the confluence of the Yolo and Kalumu rivers, or use a site near Ndola Airport (Limete commune). The volume of sludge reaching waterways has been estimated to be approximately 400 cubic meters per day (IGIP 2006; OPM 2016).

Institutions: Unlike other cities, Kinshasa does have a dedicated Sanitation and Public Works Agency (*Régie d'assainissement et des travaux publics de Kinshasa*, RATPK), which was created in 2008. Its role is to provide technical support and coordination for public cleanliness, vector control, solid waste management, and fecal sludge emptying services. RATPK has approximately 200 employees, and sanitation is one of five directorates. However, its focus in "sanitation" is almost exclusively on solid waste, which is more politically salient. While the overall sanitation budget was reportedly USD 15 million in 2016, disbursement was below 20 percent and no funds were allocated for fecal sludge management. A decree has been signed to set up a sanitation fund (*Fonds d'assainissement pour la ville de Kinshasa*, FONAK) with the aim of channeling all investments into one budget under the authority of provincial ministers of environment and finance. FONAK is not yet operational but, like RATPK, constitutes a potential future implementation vehicle.[a]

Map B5.1.1: Kinshasa Sanitation



Source: Adapted from CNAEA et al. 2015.

Ongoing activities: Present urban sanitation projects are of small scale only. A local NGO called Congo Latrines is running a fecal sludge management program with up to 5000 subscribers. One ASUREP managing an autonomous water system in

box continues next page

Box 5.1: Continued

Mikonga has taken the initiative to build public latrines for approximately 100 daily users. The French Development Agency (AFD)-funded Projet de Promotion de modalités Innovantes pour L'Accès à l'Eau Potable, à l'assainissement et à l'hygiène (PILAEP) project has supported latrine construction in selected health centers. A settlement pond project to be financed by the World Bank's IDA Urban Water Supply Project (PEMU) project did not come to pass due to local resistance and lack of clarity about institutional ownership. None of these projects have reached scale or attempted to address the entire sanitation service chain systematically.

Existing plans and possible next steps: Kinshasa would be well suited for new urban sanitation pilots, because an incipient municipal institutional structure already exists, logistics are comparatively easy, and a number of analyses and strategic plans for sanitation interventions are available.

In 2007, the World Bank financed an extensive sanitation study and action plan for Kinshasa which was never followed up (IGIP 2006). In 2013, RATPK with support from AFD developed a strategic plan for Kinshasa (Schéma d'Orientation Stratégique de l'Agglomération Kinoise, SOSAK) which provides an inventory of urban services, including sanitation. This was complemented by a 2015 review of WASH infrastructure by CNAEA, the city of Kinshasa, and WaterAid. These documents provide a wealth of information that new pilot projects can build on.

Particularly promising pilot approaches include the following: reviving earlier plans for a safe fecal sludge treatment site with clarified institutional responsibility by RATPK/FONAK; piloting decentralized wastewater treatment plants in peri-urban areas in collaboration with ASUREPs; improving existing waterways in the city to drain rain and wastewater more effectively; carrying out a study on the private market for latrine construction aimed at improving latrine quality and lowering cost.

a. Based on interviews with J. Mukunu, Director of Studies at RATPK, 2016–08–19, interview with F. Sangarina, Conseiller à la Division Provinciale de l'Environnement, Kinshasa, 2016–08–19, and with P. Mbangu, DAS, 2016–08-24.

Rural Water and Sanitation: Struggling to Scale

The rural water and sanitation subsectors are characterized by a low rate of improved access, but a moderately positive trend over the past 10–15 years (table 5.6). Despite these positive trends, the 2015 Millennium Development Goal (MDG) targets were missed. Moreover, even as access rates improved, the rural population grew so fast that the total number of rural dwellers without access to water and sanitation had increased by almost 10 million since 1990. In the case of rural sanitation, open defecation remains relatively moderate in comparison to neighboring countries, but has unfortunately increased slightly (UN 2014; UNICEF and WHO 2015). The top 60 percent (T60) of rural households by expenditure level have significantly better access to improved rural water and sanitation than the bottom 40 percent (B40), though the difference is significantly more compressed in the sanitation sector due to overall lower access across all income and wealth levels.

Table 5.6: Rural Water and Sanitation Overview

Improved Water Access in Rural Congo, Dem. Rep.			
Access Rate	Δ since 2000	Piped Access	Δ since 2000
31.2%	+4.4%	1.1%	+0.2%

Source: UNICEF and WHO 2015.

Access Rate, by Socioeconomic Status		Sub-Sector Funding	
Rural Bottom40	Rural Top60	Total 2005–20	$ per person in need of access by 2030
26.7%	34.2%	$217m	$6

Source: Enquete 123 2012; World Bank calculation.

Improved Sanitation Access in Rural Congo, Dem. Rep.			
Access	Δ since 2000	Open Defecation	Δϖ since 2000
28.7%	+9.8%	16%	+2.3%

Source: UNICEF and WHO 2015.

Access Rate, by Socioeconomic Status		Sub-Sector Funding	
Rural Bottom40	Rural Top60	Total 2005-20	$ per person in need of access by 2030
16.8%	20.7%	$214m	$5

Sources: Demographic and Health Survey 2014; World Bank calculation.

Note: Inconsistencies between overall Joint Monitoring Program (JMP) data and Demographic and Health Survey (DHS) data by socioeconomic status are due to JMP being an aggregate of data sources.

The situation appears more dire still when reviewing access in terms of the SDGs. The SDGs set more ambitious service quality goals than just improved access. The SDG safely managed water and sanitation access is virtually nonexistent in rural areas at below 0.5 percent, respectively. While about two-thirds of rural households with improved water access have their source within 30 minutes, only 1 percent have one on premises, and only a fraction of these has continuous and uncontaminated supply from this source (i.e. safely managed). In rural sanitation, less than 1 percent of households have improved toilet *and* handwashing facilities.

Funding commitments and disbursements for the period 2005–20 have remained modest overall at just over USD 430 million, less than half of funding for urban water. Over 90 percent of these funds have been implemented through or in association with the EVA program, the main arms of which are directed by UNICEF in cooperation with the MPH and Ministry of Education. The program has extended improved water and sanitation services to millions of Congolese since its inception in 2008.

The EVA program has faced three major challenges: it has struggled to sustain results, not yet overcome capacity constraints to scale up, and remained too reliant on foreign funding. A core task in rural water and sanitation will be to overcome these issues and scale up the impact of EVA. At the end of the ongoing, second phase of EVA (2013–17) many of these challenges are beginning to be addressed through the development of a post-certification processes and better prioritization of intervention areas to improve sustainability, training programs to work toward closing the capacity gap, and the adoption of new technologies to reduce costs. The extension of EVA beyond its current implementation cycle that ends in 2017 will be critical to allow these efforts to come to fruition.

The following sections aim to give a concise overview of the history and present institutional constraints in rural water and sanitation, leading to the chapter's conclusion with recommendations for next steps.

Historical Context: The Evolution of an Externally Driven Rural WASH Sector

In the dispersed rural settlements of the Congo, traditional approaches to water supply and sanitation persisted for a long time undisturbed by interventions from ever-remote government authorities. A 1927 report by the colonial government noted sporadic latrine building in villages in "certain places," but generally found unsatisfactory hygiene practices and an absence of safe, potable water even in the colony's cities. The report also noted that provincial cases of amoebic dysentery could "evidentially" be attributed "to the conditions of hygiene, and notably the question of water, which remains without solution" (Royaume de Belgique 1928, 16, 28).

While the colonial government started to invest in the expansion of urban drinking water supplies from the 1930s on, little changed in most rural areas. In the final decade of the colonial era a report highlighted that:

> [T]he vast majority of the population continues to use their ancestral water points, sometimes in the neighborhood of the village, sometimes several kilometers away. These difficult to access waterpoints are [typically] situated at the edge of a river or a pond. (Borgniez 1952, 5)

The negative health consequences had also persisted, as was well understood at the time:

> [T]he conditions of water sources are such that they expose users to […] infections, either by drinking polluted water or by wading into water in which disease vectors develop. Medical statistics give evidence of the importance of mortality and morbidity attributable to typhus, dysentery, hookworm, schistosomiasis [and] the spread of malaria. (Borgniez 1952, 6)

Systematic public interventions in the rural sector only started after World War II, in particular with the creation of the "Indigenous Welfare Fund" (Fonds du Bien-être Indigène, FBEI) in 1947. While neither the FBEI nor other actors intervened at scale in rural sanitation, rural water supply became a focus of the fund. The FBEI prioritized intervention areas by population density, high prevalence of water-borne disease and stably settled populations (de Raeve 1997, 330).

In the last decade of the colonial regime, the FBEI supported the construction of approx. 3,000 protected springs, standposts and wells in selected areas. These interventions supplied at least 770,000 rural Congolese with improved water, that is, about 6 percent of the rural population at the time (de Raeve 1997, 333; WHO and IBRD 1974, 3) Nevertheless, considering the vast rural population that remained unserved, the FBEI's achievements in rural water were still judged "far from adequate" after it discontinued its activities in 1964 (WHO and IBRD 1974, 3). Yet, with its demise, interventions declined even further.

In the mid–1970s, a study noted that there were "no adequate plans […] for the extension of rural water supplies" and "many of the existing systems, simple as they are, have fallen into disrepair". It was pointed out that "before [needed] large-scale development programmes" for "rural water supply, sewerage and drainage […] can be undertaken" capable institutions would first have to be created (WHO and IBRD 1974, iii).

Yet such institutions remained elusive. Though formal responsibility rested with the state's Rural Development Office in the Agricultural Department (*Bureau du Développement Rural*), the government gave "low priority […] to rural development" and the "little that has been done in this sector since independence has been undertaken mostly by [AIDR], a non-profit Brussels based organization, and by UNICEF" (WHO and IBRD 1974, 3-4). In 1977, UNICEF supported the creation of a Rural Water Project, which, in 1983, developed into the National Rural Water Service (SNHR) in the Department of Agriculture and Rural Development. Although SNHR

eventually developed a nationwide presence with hundreds of staff, it remained primarily externally funded and "in reality most rural water development in Zaire is carried about by [private voluntary organizations] or religious missions" (Warner and Leger 1984). In the early 2000s, SNHR's budget (excluding salaries) was a mere USD 61,000 (UNEP 2011, 36).

The Department of Public Health (now MPH) also started to intervene in rural water supply, but did so only sporadically and at a limited scale (e.g., some 300 protected springs and 5 wells in 1981–84). A study by WHO at the time also noted that beyond geographically limited interventions, primarily by NGOs and UNICEF, potable water is "practically inexistent" in rural areas, the availability of latrines "very insufficient" and access "probably not exceeding 10 percent" of the population (WHO 1982, 6-7, 9). For larger rural settlements, WHO recommended a concerted water and sanitation infrastructure construction effort of the Rural Development and Public Health offices in cooperation with NGOs, while for smaller, dispersed rural settlements it thought "water or sanitation coverage by public means impossible to envisage" and instead recommended "education campaigns" (WHO 1982, 8)

Historically, the institutional framework of the rural water and sanitation sector has thus developed slowly and remained highly reliant on external and non-state actors: first the FBEI, and later AIDR, UNICEF, and a host of associated national and international NGOs. The role of external agencies has only increased as the chaos of the 1990s and early 2000s further eroded the capacity of state institutions. External support and non-state agencies will continue to play a critical positive role in the sector, but will not be able to substitute for functional local government at scale. This is illustrated by the EVA program, which has become the most important intervention in rural WASH in the Democratic Republic of Congo since its launch in 2008.

Institutional Constraints in Rural WASH: EVA and the Limits of the Externally Driven Approach

The EVA program is today by far the largest rural WASH program in the Democratic Republic of Congo, absorbing over 90 percent of funding in rural WASH (figure 5.2). Due to its unique scope and importance, EVA's institutional structure and challenges are reflective of those of the rural WASH sector as a whole. A first phase of EVA was implemented in 2008–12, investing nearly USD 100 million, and a second phase for the period 2013–17 is ongoing with a budget in excess of USD 150 million.[6] Virtually the entire program is externally funded, primarily by DfID. Formal responsibility for EVA rests with the MPH and Ministry of Education (MoE), with supervisory and coordination roles extending to the deconcentrated provincial offices of these ministries. In practice, however, UNICEF manages EVA at national level and execution in the field is overwhelmingly done by sub-contracted NGOs and private partners. Under the UNICEF umbrella, over 150 local and international partners have been implementing the project (UNICEF 2016)

The aim of the EVA program is the achievement of WASH-related "norms" upon which the respective village or school is declared "healthy." These targeted norms are key water, sanitation, and hygiene indicators, and are listed in table 5.7 for villages and schools, respectively.

In late 2016, the EVA program reported having certified 6,504 villages and 1,720 schools as "healthy" since the start of the program in 2008. The program had extended potable water access to over five million rural dwellers, improved sanitation facilities to over 4.5 million, and handwashing with soap to over 4.2 million. This represents approximately 10 percent of the rural population in 2016.[7] Over 600,000 pupils gained access to safe water, sanitation and handwashing (MPH 2016). The program also reported significantly reduced diarrheal disease-related morbidity and mortality in certified villages (UNICEF 2016). Map 5.3 highlights all health zones in the country in which the EVA program was active, though generally not covering the entire population in each.

Table 5.7: Norms Required for a Village or School to Be Declared "Healthy" under the EVA Program

	Healthy villages	Healthy schools
Norm 1	Village has a sanitation committee	At least 80 percent of schoolchildren have access to drinking water at school
Norm 2	At least 80 percent of the population has access to clean water	At least 80 percent of boys and girls utilize hygienic toilets at school
Norm 3	At least 80 percent of households have access to hygienic latrines	At least 80 percent of schoolchildren wash their hands with soap/ash before eating and after using the toilet
Norm 4	At least 80 percent of households dispose of their solid waste hygienically	The school has a clean environment
Norm 5	At least 60 percent of the population washes their hands with soap or use ash before preparing food or eating, and after latrine use	
Norm 6	At least 70 percent of the population understands the fecal-oral route of disease transmission and how to prevent it	
Norm 7	The village is cleaned at least once a month by the community	

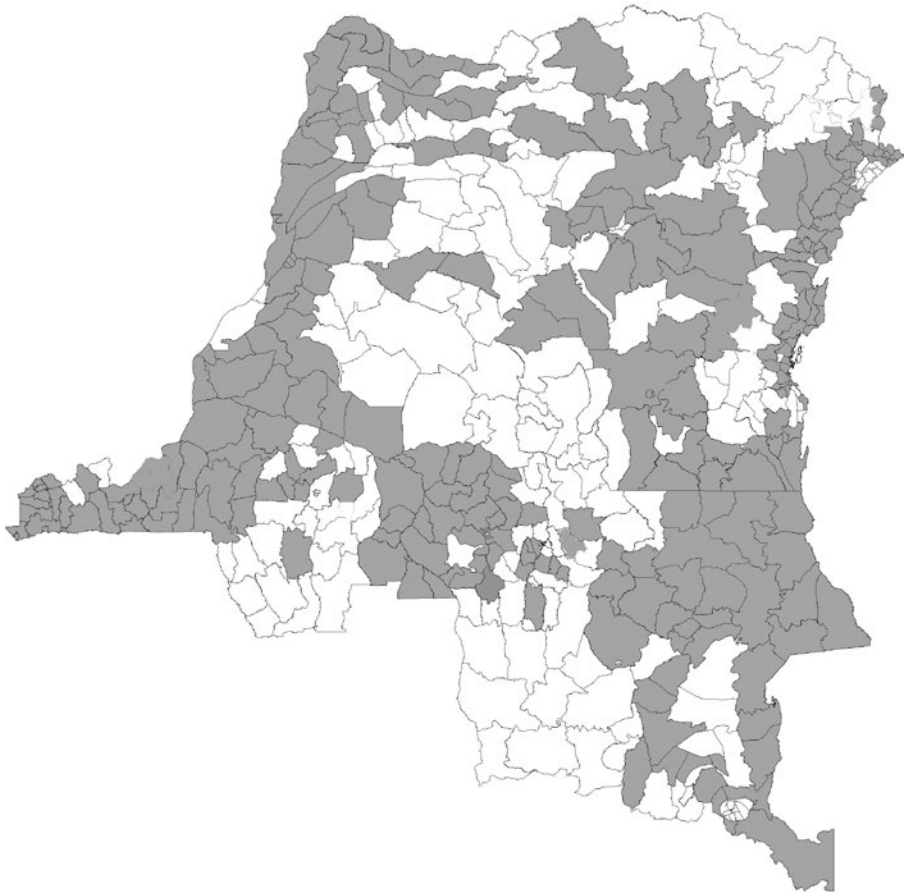
Source: UNICEF.

Despite these achievements, the EVA program has faced three key challenges: sustaining achieved results; overcoming capacity constraints to scale interventions; and a dependence on external funding and expertise for implementation.

The sustainability of the results of EVA has been low. In a sample of 1,832 certified villages, only 7 percent maintained all seven norms at the first post-certification visit. While nearly 30 percent of villages failed to maintain sufficient improved water access and handwashing, almost 80 percent did not sustain the improved sanitation norm (MPH 2016). Data from a sub-sample of schools in four provinces showed wide variation, with between 15 percent and 75 percent of schools maintaining all four school norms and thus their "healthy" status. Repeated post-certification visits assisted many target locations in re-gaining their "healthy" status. Nevertheless, the sustainability results highlight the risk of rapid erosion of initial gains of EVA in WASH access, underlining the importance of quality control among the many implementing agencies and repeated reinforcement of initial achievements through post-certification revisits. Such revisits have major budget implications, forcing a trade-off between consolidation of results and further expansion, and thus constitute a significant constraint on EVA scale-up. Moreover, it remains unclear at what point results can be sustained without further revisits.

An expansion of the EVA program is critical if SDG targets are to be met, yet the present institutional structure is struggling to scale. Although the number of beneficiaries of the EVA program over the period 2008–16 is unprecedented in the rural WASH sector of the Democratic Republic of Congo, the rural population grew faster still during the same period, even before

Map 5.3: Health Zones with EVA Interventions



Source: UNICEF.
Note: Shaded areas represent EVA interventions.

taking imperfect sustainability into account. Scaling further to achieve the SDGs would require not just more finance, but the capacity to absorb it. With over 150 partners already engaged, UNICEF, MPH, and MoE are struggling to maintain the desired quality and pace of implementation (UNICEF 2016). Moreover, a more specific systematic capacity gap of EVA is its focus on point-sources and its limited expertise in constructing small piped networks in larger rural settlements with a conducive environment (for example, allowing a gravity-fed scheme), which have helped millions of Congolese gain access to convenient piped water in the past.

EVA funding requirements—over USD 30 million per year in Phase 2—are substantial and the almost complete reliance on external financing is a key risk to the program. Funding risks are particularly high given close to 75 percent of Phase 2 funding is from a single source (the Department for International Development [DfID]) and a freezing or non-renewal of funding would be difficult to replace. Repeated revisits to sites to sustain results, and increased capacity building to create the foundation for larger-scale efforts are critical if progress toward the SDGs is to be realistic. In rural areas, there are few WASH programs which are not partly supported or at least associated with EVA, and none of comparable scale.

Key Challenges for Pro-Poor Service in Rural Water and Sanitation

The EVA approach is well suited to achieving pro-poor outcomes within the villages and schools it targets, however, reaching smaller and more remote poor communities remains a challenge. The EVA program is fundamentally community driven in the tradition of the community-led total sanitation approach (CLTS). Thus, EVA promotes the inclusion of the most vulnerable, such as female-headed households, elderly, disabled, and the poorest within villages in which the program is implemented. However, given the sheer scale of rural WASH needs and the wide distribution of rural villages, limited project budgets must prioritize locations that are easier to reach, offer at least some economies of scale (that is, sufficient population), and have a basic ability to economically sustain interventions. There is thus a clear tension between equity and efficiency in rural WASH.

While to some extent unavoidable in a context of limited resources, it will remain important that prioritization of interventions is not seen as a binary choice, and that opportunities to differentiate interventions are explored. Thus, while a full-scale EVA intervention with drilled wells and sophisticated toilet facilities may not be suitable for a particularly remote, small, and poor village, a more limited menu of small-scale actions could perhaps still be considered (such as solar disinfection of water, manual drilling, and so on).

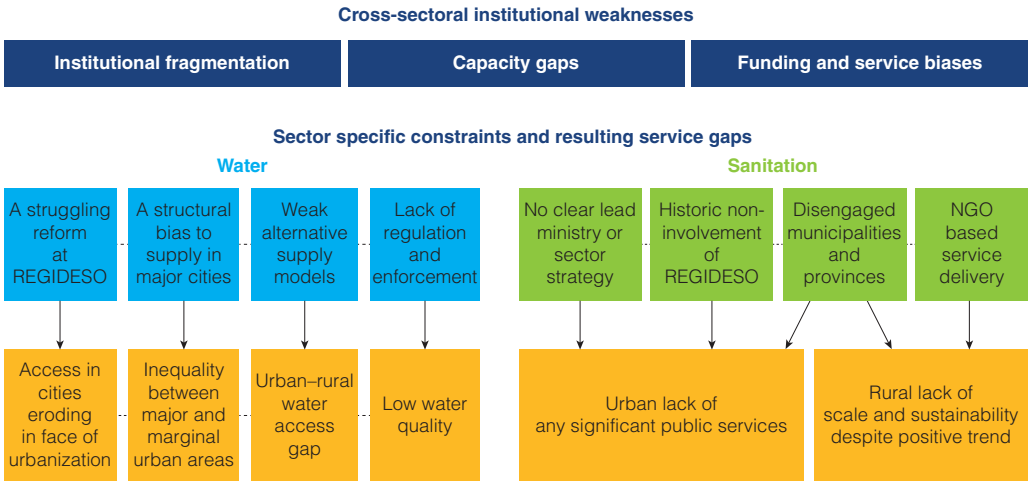
This equity–efficiency dilemma applies only where the program has a presence at all. As outlined, the vast majority of the rural population and rural poor are not reached at all due to capacity, financing, and sustainability constraints. When needs are so universal, targeting and differentiation of interventions is a second-order problem compared to the need to build a permanent program capable of operating at the required national scale. Ultimately, the pro-poor reach of the EVA program will depend on whether the current externally driven and financed program can be transformed into a scaled-up, effective permanent program anchored in national institutions and able to deploy the full range of WASH technologies, including small gravity-fed water networks, as appropriate.

Conclusion

The WASH sector in the Democratic Republic of Congo faces a variety of persistent, structural challenges. The overarching issues are the sector's institutional fragmentation, capacity gaps (especially at decentralized level), related systematic biases in funding, and poor governance, which collectively undermine the ability of the sector to cope with rapid demographic and socioeconomic change.

The overarching institutional challenges manifest in varied ways at subsector level. In urban water supply, the erosion of access and increasing gaps between major and minor cities are directly related to the concentration of funds on a REGIDESO that is struggling to reform itself and reach beyond its traditional core service centers. The weakness and underfunding of alternative supply models and rural institutions has further aggravated REGIDESO's limitations. The institutional fragmentation at national level and absent regulatory capacity has prevented a systematic understanding of the scale of water quality problems, much less enforcement. Urban sanitation services are nonexistent due to the lack of policy leadership disengaged municipalities and non-involvement of the national water utility, which limit the implementation capacity of the subsector. While the EVA Program has attracted significant funds to rural areas, it has struggled to sustain and scale up results due to weak capacity of rural state institutions support its NGO-driven service-delivery model. Figure 5.5 provides a brief overview of the most central constraints and resulting service gaps outlined in this chapter.

Figure 5.5: Core Service Gaps in Water and Sanitation and Underlying Institutional Weaknesses



Note: NGO = nongovernmental organization. REGIDESO = National Urban Water Distribution Agency.

The new Water Law and Policy are no panacea for the varied sector challenges, but provide momentum and a legal basis to start addressing many core issues. The impact of the new Water Law and associated policy on the institutional structure and associated service gaps is potentially profound: A dedicated water ministry, regulator and potential re-ordering of the sanitation sector could decisively reduce fragmentation and provide stronger leadership on issues such as water quality. The recognition of the principle of at-cost tariffs could improve cost recovery while investments in marginal urban areas could be boosted by the shift to provincial government responsibility for infrastructure and support for delegated management and autonomous systems. Decentralization of responsibility could also strengthen local government's role in donor-financed rural WASH programs. A key challenge going forward will be realizing the law's potential in face of an entrenched sector structure and complex political reality.

Two complementary approaches to implementing the law may be discerned. The first approach emphasizes the gradual creation of the administrative, regulatory, and legal structures to apply the law in practice. The second approach posits that the law already provides a basis for key principles such as decentralized asset ownership, service delegation and at-cost tariffs to be realized, and calls for projects to create practical precedents. A sole focus on formal process risks losing momentum and entrenching the status quo.

Government and donors should balance the two approaches. As outlined in the key recommendations at the top of this diagnostic, strong support to create institutional ownership for the law and the development of required decrees will be critical, but can be combined with an operational focus on particularly pressing service needs. Thus, a proto-regulator and ministry could help prioritize regulation and pilot projects around core service gaps, such as water quality and malnutrition, or the service biases toward large cities. This could imply, for instance, combining decrees setting water quality norms and consequences for non-compliance with investments to test water more systematically, or support to develop delegated management contracts in urban water with province-level investments beyond only REGIDESO.

A mapping of gaps and challenges thus provides a starting point to unpack the complexity of WASH in Democratic Republic of Congo and to prioritize interventions that can respond to current and future needs. Chapters 2 and 3 of this diagnostic highlighted the scope of the

challenge: limited progress in improving WASH access and weak quality of service, in the face of rapidly growing demand due to demographic growth and rapid urbanization compounded by the country's size and protracted fragility. Chapter 4 emphasized the cross-sectoral linkages of WASH with health and nutrition. In a context of high poverty and malnutrition, addressing the lack of safe WASH can play a key role in protecting the foundations of the Democratic Republic of Congo's potential for development. While emergency interventions such as point-of-use treatment may provide short-term relief, long-term improvements will depend on fixing the institutional weaknesses that underlie the profound gaps in WASH services in the Democratic Republic of Congo.

Notes

1. As of January 2017, the PNSPE was validated by the Ministry of Energy and Water Resources (MEWR) transmitted to the premiership and is awaiting validation by the council of ministers.
2. EVA funds estimate includes USD 50 million+ from the African Development Bank's (AfDB) Reinforcement of Socio-Economic Infrastructure in the Central Region (PRISE) project, which was part of the [EVA] Programme" (AfDB 2013), though not via UNICEF.
3. The government allocation excludes the budget allocated to paying water bills (which also remained largely undisbursed).
4. In 1973, REGIDESO was granted a new charter, which increased its operational autonomy, but tightened the state's overall control over the budget and strategic decisions, with a general manager appointed directly by the President (WHO and IBRD 1974). In 1978, REGIDESO's statutes were amended with the ordinance n°78–197, and in the context of a new public enterprise law (n°78–002), which formalized its position as the sole urban water supplier. The legal monopoly was further strengthened in 1986 by a Ministerial Decree (n°0014/DPT-MINER/86) prohibiting the use of natural water, other than that supplied by REGIDESO (ICEA-Mazars 2008).
5. Beneficiary hereby counts sharing and resale of water across households. The calculation is based on actual disbursements of the IDA P091092 grant H4350 on "goods and works" divided by connections made as reported in the project paper PAD1542 at near full (97.4 percent) disbursements. The cost estimate per household members used average urban household size (5.7) as per the DHS 2013–14. The per beneficiary estimate used results from the WASH Poverty Diagnostic household survey in Kinshasa on the number of households piped connections are shared with. Note that the resulting per beneficiary cost estimate of USD 141 is close to a recent estimate of USD 154.3 for piped on premises supply per person in the Democratic Republic of Congo estimated in a recent paper on SDG costs. (Hutton and Varughese 2016).
6. In addition, two years for post-program evaluation until 2019 are planned.
7. World Bank, World Development Indicators, Indicator SP.RUR.TOT.

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Appendix A Activities and Delivery Package for Democratic Republic of Congo WPD

Table A.1: Overview of Research Outputs Associated with the WASH Poverty Diagnostic for the Democratic Republic of Congo

Activity	Topic	Spatial coverage	Data	Sector coverage	Core question	Delivery date	Status
1	**Poverty review**	National	All available household surveys (Enquête 123; DHS; MICS)		CQ1	June 2016	Completed and QER
2	**WASH and poverty linkages**	National	All available household surveys (Enquête 123; DHS; MICS)	WSS and health	CQ2	June 2016– QER on existing data; December 2016/early 2017 for WPD survey data	Completed and QER for existing data
3	**WASH-PRM for estimating disease burden**	National	DHS-EDS 2014	WSS and health	CQ3	October 2016	Completed
4	**Household survey phase 1**	Kinshasa and Tchonka (South Kivu)	Household survey data + children anthropometrics + water quality testing	WSS and health	CQ2 and CQ3	FY16	Completed
5	Household survey phase 2 (Funded by the JICA Nutrition TF)	Kindu (Maniema) and Equateur (Basankusu + rural sites)	Household survey data + children anthropometrics + water quality testing	WSS and health	CQ2 and CQ3	FY17	Completed
6	Methodological note on survey design				CQ2	June 2017	First draft, completion in FY17

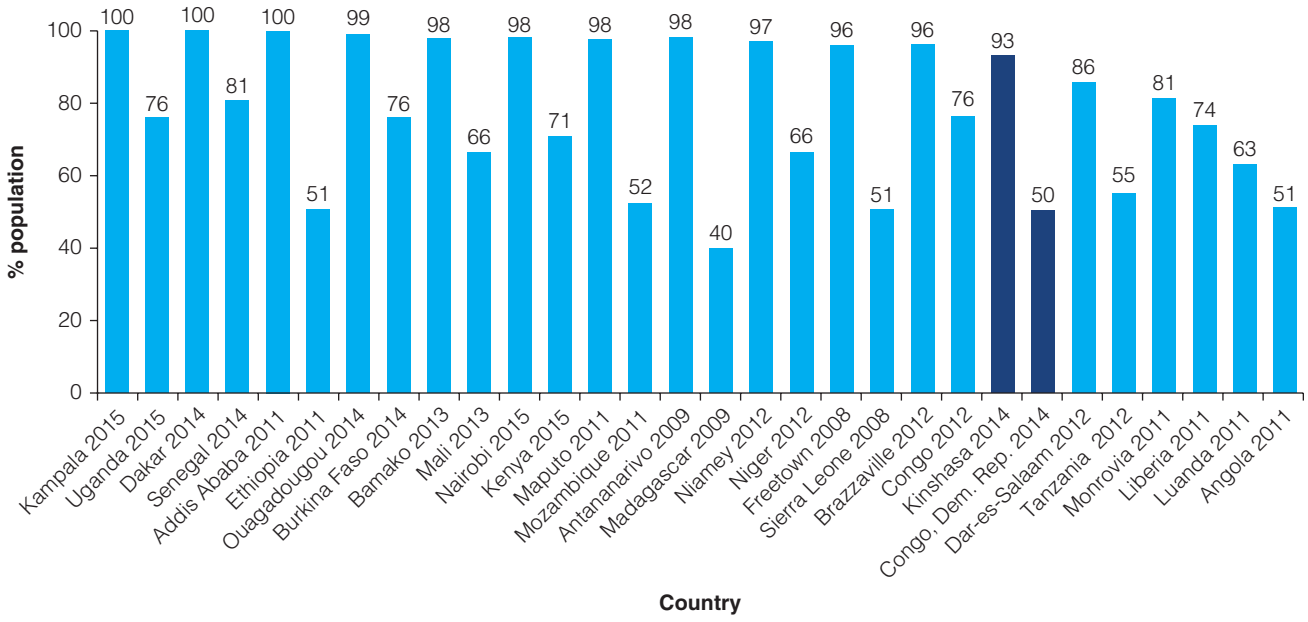
table continues next page

Table A.1: continued

Activity	Topic	Spatial coverage	Data	Sector coverage	Core question	Delivery date	Status
7	**UNICEF framework analysis (food, care, health, and WASH linkages)**	National	DHS-EDS 2014; expanded partially post QER to include data from the 2007 DHS	WSS and health	CQ3	June 2016	Completed and QER
8	Nutrition report	National	Report aggregating inputs from analysis of WPD surveys, DHS surveys, synergy analysis, and PRM	WSS and health	CQ3	June 2017	Ongoing
9	**Institutional analysis**	Kinshasa + Urban		WSS	CQ4	Nov 2016	First draft finished
10	Utilities' performance analysis	National		Urban Water	CQ4	Sep 2016	Completed

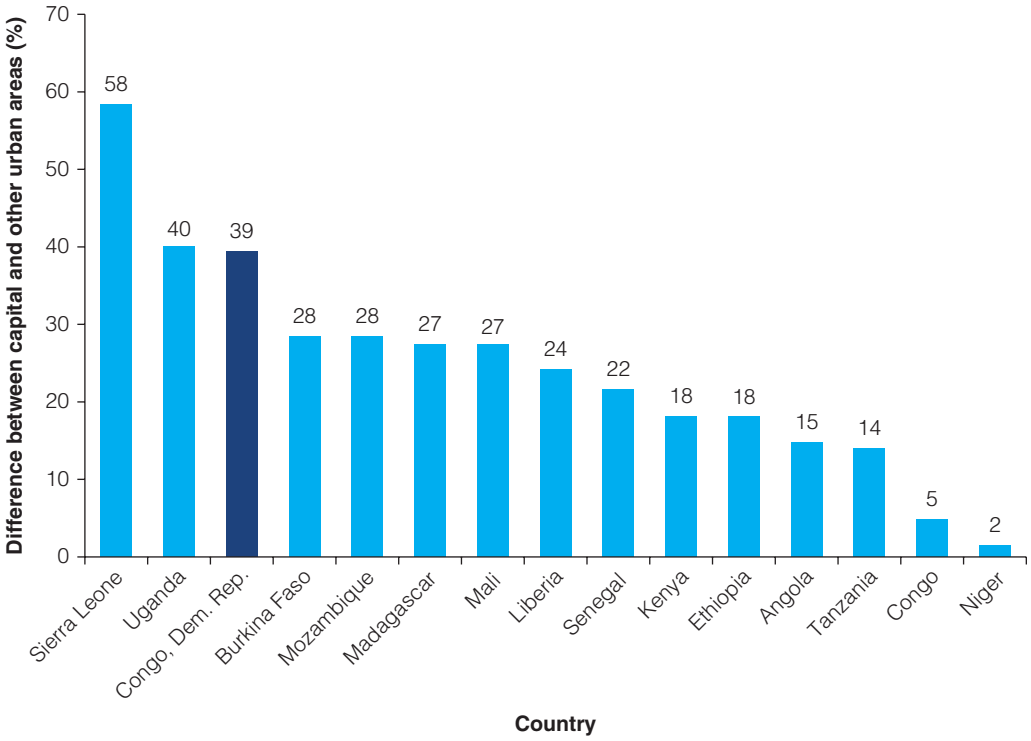
Appendix B
A Regional Perspective on Metropolitan, Urban, and Country WASH Access Gaps

Figure B.1: Access to Improved Water in the Country Compared with Capital Areas



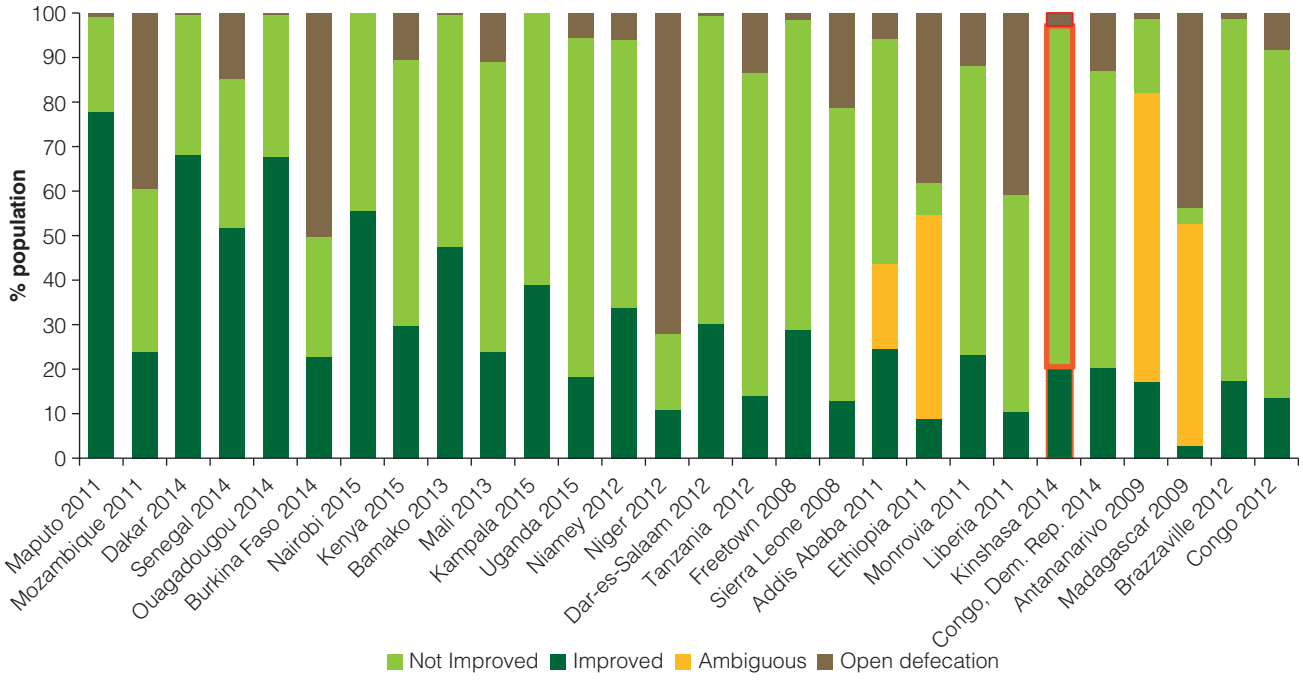
Source: Latest DHS available for the respective countries.

Figure B.2: Ranking of Countries in Access to Piped Water, by Gap between Capital and Other Urban Areas



Source: Latest DHS available for the respective countries as of January 2017.

Figure B.3: Access to Sanitation: Comparison of the Capital with Country



Source: Latest DHS available for the respective countries.

Appendix C
Democratic Republic of Congo WPD Household Survey Design and Methodology

The Democratic Republic of Congo WPD carried out household surveys in seven communes of Kinshasa, the city of Kindu (the capital of the province of Maniema), the small town of Tchonka (South Kivu), the small town of Basankusu (Equateur) and the two rural hamlets of Bomate and Liyata in Equateur province. In each location, water quality tests (*E. coli*, nitrates, nitrites, free and total chlorine) were carried out for a subset of households. Table C.1 gives an overview of the survey size and number of water quality tests in each location.

In contrast to existing surveys (DHS, Enquête 123, MICS), which are only representative at the province level, the WPD surveys provide an unprecedented city- (and in the case of Kinshasa, intra-city) and village-level view on the full set of water and sanitation variables, including estimates of poverty status using the SWIFT methodology (see below) and water quality testing, which is not typically part of household surveys.

Table C.1: Households Survey Size and Number of Water Quality Tests, by Location

Site	Number of Households Surveyed	Number of Water Quality Tests
Kinshasa (Total 7 Communes)	3,147	1,705
Commune of Kasa-Vubu	442	237
Commune of Kinshasa	452	239
Commune of Ndjili	538	245
Commune of Makala	482	242
Commune of Kisenso	411	247
Commune of Kimbanseke	410	249
Commune of Mont Ngafula	412	246
Kindu (Maniema)	1,623	795
Tchonka (South Kivu)	706	502
Basankusu (Equateur)	218	213
Bomate (Equateur)	122	116
Liyata (Equateur)	194	181
Total	**6,010**	**3,512**

Background: Common Methodological Problems for Surveys in Fragile States

A core problem for surveys in developing countries, particularly in fragile states, is the lack of a sampling frame. In the Democratic Republic of Congo, the last census was conducted in 1984 and no detailed administrative data is available. This makes it difficult to select an efficient and unbiased sample, which ideally requires a complete sampling frame of the population of interest (e.g., a recent census) from which a random sample can then be selected.

Most national household surveys (LSMS, DHS, MICS, etc.) deal with this problem by using a two-stage cluster-sampling approach. An (approximate) administrative census is used to draw a first-stage sample of clusters/enumeration areas/primary sampling units, and then do a field listing of all households within the selected PSU. Finally, a second-stage random sample of households within each enumerated PSU is drawn.

This two-stage cluster-sampling method has three disadvantages: (i) the administrative census that is the basis for the first-stage selection of PSUs (e.g., by probability proportional to size; PPS) can be quite unreliable; (ii) the process of listing households within selected PSUs before the second-stage draw is expensive; (iii) the two-stage sampling is inefficient due to the intra-cluster correlation, which is particularly elevated in the case of infrastructure—in other words, for the same estimate precision (margin of error), the sample size has to be larger to compensate for the loss of information because observations within PSUs are more similar to each other than if chosen randomly across the entire area of interest.

Sampling Strategies in the WPD Survey

The surveyed households were selected randomly in all sites, except in the small hamlets of Bomate and Liyata, in which all households were surveyed in what thus amounts to a village census.

In the sites in which households were selected randomly, different methods of random selection were employed depending on the availability of sampling frames from which to draw the households. This flexible approach ensured properly randomized unbiased samples while minimizing costs. The following random selection methods were used:

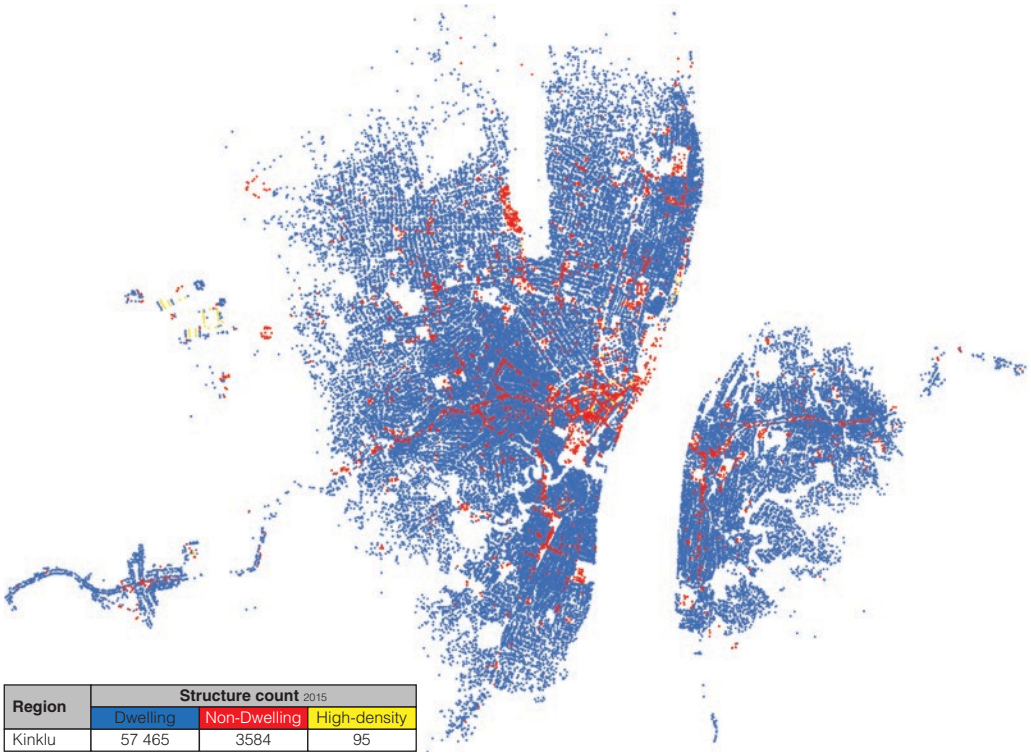
- *One-stage random sampling based on local census*

This method was used in the communes of Kinshasa and Kasa-Vubu, for which a recent local census of households was available. This method does not require additional listings in the field, is unbiased and efficient, minimizing the margin of error in estimates, *ceteris paribus*. The household census from which the sample was randomly drawn was carried out after 2013 by Manobi for the national utility REGIDESO as part of a World Bank investment project covering all households in selected communes. A verification exercise for the census data was carried out in a subsection of the communes. The sample was then drawn randomly from the full census using a random-number generator.

- *One-stage random sampling based on satellite counts of dwellings*

This innovative method was used in the communes of Kisenso, Kimbanseke, and Mont Ngafula, as well as in the sites of Kindu, Tchonka, and Basankusu, for which no census was available. In a first step, the project used recent (2012–15) satellite images of the survey sites to count and geolocate all dwelling units, excluding units likely to be businesses (map C.1, see below for details). Each geolocated dwelling was then assigned a random number, and a sample was selected through a one-stage random draw.

Map C.1: Completed Count of Dwellings (57,645), Nondwellings (3,584), and High-Density Buildings (95) in the City of Kindu



Region	Structure count 2015		
	Dwelling	Non-Dwelling	High-density
Kinklu	57 465	3584	95

Source: Satplan Alpha 2016.

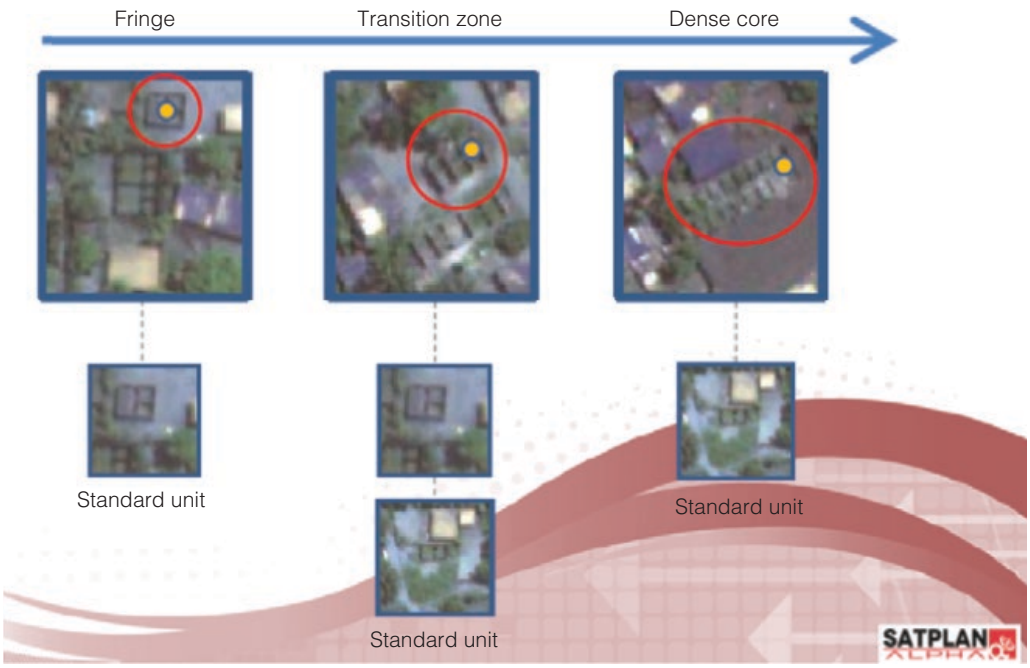
The counting and geolocation of dwelling units to compile the sampling frame was done manually and took into account a detailed understanding of typical dwelling units in the Democratic Republic of Congo in order to account for multiple-household buildings and to identify units likely to be businesses.

A standard "dwelling unit" of one household was defined taking into account that these can differ not just between cities, but also within cities, varying from dense inner-districts to peri-urban and even semi-rural areas at the outskirts. Consultants counting dwelling units took into account architecture (main dwelling versus backroom etc.), building size and features (dwelling threshold), roof segmentation, roof design intricacy, and height, building orientation (i.e. parallel to road has higher likelihood of being commercial non-dwelling units), site boundary features (lack of a fence-boundary wall, especially in peri-urban areas makes it less likely to be a dwelling unit), closeness to major streets, street activity and traffic (buildings very close to large busy streets are more likely to be commercial). Examples of standard dwelling units are given in Figure C.1.

- *Two-stage random sampling (Kinshasa communes Kinshasa and Kasa-Vubu)*

This method was used for the Kinshasa communes of N'djili and Makala for which neither a pre-existing census nor a satellite count and individual geolocation of dwellings was available at the time of surveying. The method is a variation on the two-stage cluster-sampling approach described above, i.e. a first-stage definition and draw of clusters, then a field enumeration of selected clusters, followed by a second-stage draw of enumerated houses within clusters. As noted above, this approach is unbiased, but not as efficient as the one-stage draw methods used in the other sites.

Figure C.1: Examples of Buildings and the Standard Dwelling Units They Contain (Roofless for Illustration)



Source: SATPLAN ALPHA.

With an out-of-census survey and outdated administrative census, the first stage of the sampling strategy was the definition of the primary sampling unit (PSU) for Kinshasa using satellite images. Those primary sampling units, renamed remote sensing unit (RSU) to avoid confusion with the PSU defined by the National Statistical Office (INS), were defined using four criteria:

- Ranked by size
- Logical and respecting administrative boundaries
- Identifiable by enumerators/surveyors on the ground
- Have descriptive physical characteristics (area, elevation, distance to central business district, land use, etc.).

Multiple sources of data were used: administrative unit boundaries, openstreetmap street data, land-use polygons, and satellite imagery. Finally, to allow weighing the first-stage selection by population an automated algorithm on satellite imagery was used to estimate the number of housing units in each RSU (Figure C.2).

In the communes, a cluster-sampling approach is used based on the RSUs for those communes: selecting 33 percent of said RSUs in a first-stage PPS random selection of the sampling units. A listing of all the households in the selected RSUs was then carried out in the field using GPS-enabled mobile devices. Finally, a second-stage sample of households was selected, and subsequently surveyed.

Field Implementation

The survey was implemented by a consultancy firm deploying experienced local survey staff moving in teams of two to ensure quality control and security of surveyors. Staff underwent

Figure C.2: RSUs Defined by Natural and Administrative Boundaries

detailed training of four days. A first pilot phase in February 2016 included two training sessions, and field-pilots to test the questionnaire, water quality tests, anthropometric measurement equipment, team, and leadership quality. During the survey implementation, surveyor teams were issued with detailed route-plans for the day by the survey leaders who supervised through monitoring incoming data and in the field.

Households that were not present were revisited, and if not available upon revisit (e.g., due to the building being abandoned), the household was replaced with another randomly selected household.

The Questionnaire

The questionnaire was based on standard validated survey questions from surveys such as the Demographic and Health Survey (DHS), which were complemented by specialized questions querying further details, SWIFT questions to estimate poverty (see below), as well as anthropometric measurements of children under five and water-quality testing. Questionnaire length varied slightly by site but was approximately 75 questions long with key sections on household characteristics (e.g., number, sex, age of members), health (e.g., incidence of diarrhea among children, breastfeeding, disabilities, anthropometric measurements of under five year olds), water, sanitation, and hygiene, and issues of general well-being and nutrition.

The questionnaire was field tested from February to April 2016 to identify and adjust for any difficulties in understanding questions.

The SWIFT Methodology

The SWIFT methodology was integrated into the questionnaires to allow a rapid evaluation of approximate household poverty status. The SWIFT method uses the latest household questionnaire that contains expenditure data (in the case of the Democratic Republic of Congo, we used Enquête 123 2012) to create a model that identifies a small set of core questions that will allow estimation of the expenditure level (i.e. poverty status) of the household. The selected questions are chosen to have the highest predictive value for the household's expenditure level, and the answers to these questions are used to estimate household poverty status after the survey. SWIFT is thus a powerful survey instrument that can produce estimates of poverty and shared prosperity in a very timely and cost-effective manner.

Water-Quality Testing

In each site, a subset of households selected for surveying was randomly selected for water-quality testing. Water was tested at point of use, that is, households were asked to pour a glass of water as if they would drink it themselves, which was then tested for *E. coli* contamination, nitrates, nitrites, and free and total chlorine using field-testing equipment.

For nitrate and nitrite testing, Hach test strips were used (Product #: 2745425).[1] For testing free and total chlorine, Hach Color Disc Test Kits (Model CN-66) were used.[2] For testing for *E. coli* contamination, a new, cheap and easy-to-use field-testing kit by Aquagenx was used (CTB II).[3]

Notes

1. http://www.hach.com/nitrate-and-nitrite-test-strips/product?id=7640211606.
2. http://www.hach.com/chlorine-free-total-color-disc-test-kit-model-cn-66/product?id=7640219519andcallback=qs.
3. https://www.aquagenx.com/how-to-use-the-cbt/.

Appendix D Household Surveys Data Available for the Democratic Republic of Congo

Table D.1: Overview of National Household Surveys Available for the Democratic Republic of Congo, Post-2000

Source	Enquête 123 (2005 and 2012)	MICS (2001 and 2010)	DHS (2007 and 2013–14)	WFP CFSVA (2010–11)
Used in the WPD	Yes	Yes (2001)	Yes	Not used
Description	National Household Survey	National Household Surveys	National Household Surveys	Rural Areas Household Survey
Representative	District (confirm)	Province	Province	Rural areas of province
EAs geocoded	Yes (2012 only)	No	Yes (both 2007 and 2013–14)	No, but can be mapped to 4th admin level
Water				
JMP definition of "improved"	Yes	Yes	Yes	Yes, but only improved/ unimproved (no details)
Fetch time	No standard question for water, only: "Search for wood or water, or gone to market"	Yes, by minute (also who fetches)	Yes, by minute (but not who fetches)	Yes (<15 minutes, 15–30, 30–60, more than 1 hour) (also who fetches)
Point-of-use treatment	No	Yes (incl. method)	Yes (incl. method)	No
Cost of Water	Yes (water bill and other water expenses, FC)	No	No	No

table continues next page

Table D.1: continued

Source	Enquête 123 (2005 and 2012)	MICS (2001 and 2010)	DHS (2007 and 2013–14)	WFP CFSVA (2010–11)
Sanitation				
JMP definition of "improved"	Approximately ("latrines aménagées")	Yes	Yes	Approximately (improved, unimproved, bush)
Method of child stool disposal	No	No	Yes	No
Handwashing	No	Yes (whether they wash and availability of water)	Yes (presence of water/soap)	No
Poverty statistics	Consumption data and asset wealth index Self-perception: "Thinks that the people of the village are poor"/"Main reason for poverty"	Asset wealth index only	Asset wealth index only	Consumption and asset wealth data
Relevant health data	"Had a health problem in past four weeks" "Principal type of Health Problem" (includes diarrhea)	Child weight/ height; child diarrhea (self-reported); mortality	Child weight/height; anemia; child diarrhea (self-reported); mortality	Only "cases of illness in past 12 months"
Notes	—	Mortality data needs to be computed;	Health statistics by individual, need to be compiled; mortality data needs to be computed	—

Appendix E
Joint Monitoring Program Indicators

Table E.1: Drinking Water

Country	Year	Urban			Rural			National			Progress towards MDG target	2015 pop. that gained access since 1990 (%)
		Improved			Improved			Improved				
		Total improved (%)	Piped on premises (%)	Other improved (%)	Total improved (%)	Piped on premises (%)	Other improved (%)	Total improved (%)	Piped on premises (%)	Other improved (%)		
Democratic Republic of the Congo	1990	86.5	48.2	38.3	24.7	0.9	23.8	43.6	15.4	28.3		
	1991	86.5	48.2	38.3	24.7	0.9	23.8	43.9	15.6	28.3		
	1992	86.5	48.2	38.3	24.7	0.9	23.8	44.2	15.8	28.4		
	1993	86.5	48.2	38.3	24.7	0.9	23.8	44.4	16.0	28.5		
	1994	86.2	46.7	39.5	25.0	0.9	24.1	44.8	15.7	29.1		
	1995	86.0	45.3	40.7	25.3	0.9	24.4	45.2	15.5	29.7		
	1996	85.8	43.9	41.9	25.6	0.9	24.7	45.6	15.2	30.4		
	1997	85.5	42.5	43.0	25.9	0.9	25.0	46.0	14.9	31.1		
	1998	85.3	41.1	44.2	26.2	0.9	25.2	46.4	14.7	31.7		
	1999	85.0	39.7	45.4	26.5	0.9	25.5	46.8	14.4	32.4		
	2000	84.8	38.2	46.5	26.8	0.9	25.8	47.1	14.0	33.1		
	2001	84.5	36.8	47.7	27.1	1.0	26.1	47.5	13.7	33.8		
	2002	84.3	35.4	48.9	27.4	1.0	26.4	47.9	13.4	34.5	Limited or no progress	31

table continues next page

Table E.1: continued

Country	Year	Urban			Rural			National			Progress towards MDG target	2015 pop. that gained access since 1990 (%)
		Improved			Improved			Improved				
		Total improved (%)	Piped on premises (%)	Other improved (%)	Total improved (%)	Piped on premises (%)	Other improved (%)	Total improved (%)	Piped on premises (%)	Other improved (%)		
	2003	84.0	34.0	50.1	27.7	1.0	26.7	48.2	13.0	35.2		
	2004	83.8	32.6	51.2	28.0	1.0	27.0	48.6	12.7	35.9		
	2005	83.5	31.2	52.4	28.2	1.0	27.2	49.0	12.3	36.7		
	2006	83.3	29.7	53.6	28.5	1.0	27.5	49.3	11.9	37.4		
	2007	83.1	28.3	54.7	28.8	1.0	27.8	49.7	11.5	38.2		
	2008	82.8	26.9	55.9	29.1	1.0	28.1	50.0	11.1	38.9		
	2009	82.6	25.5	57.1	29.4	1.0	28.4	50.4	10.7	39.7		
	2010	82.3	24.1	58.2	29.7	1.1	28.7	50.7	10.2	40.5		
	2011	82.1	22.7	59.4	30.0	1.1	29.0	51.1	9.8	41.3		
	2012	81.8	21.2	60.6	30.3	1.1	29.2	51.4	9.3	42.1		
	2013	81.6	19.8	61.8	30.6	1.1	29.5	51.8	8.9	42.9		
	2014	81.3	18.4	62.9	30.9	1.1	29.8	52.1	8.4	43.7		
	2015	81.1	17.0	64.1	31.2	1.1	30.1	52.4	7.9	44.6		

Table E.2: Sanitation Facilities

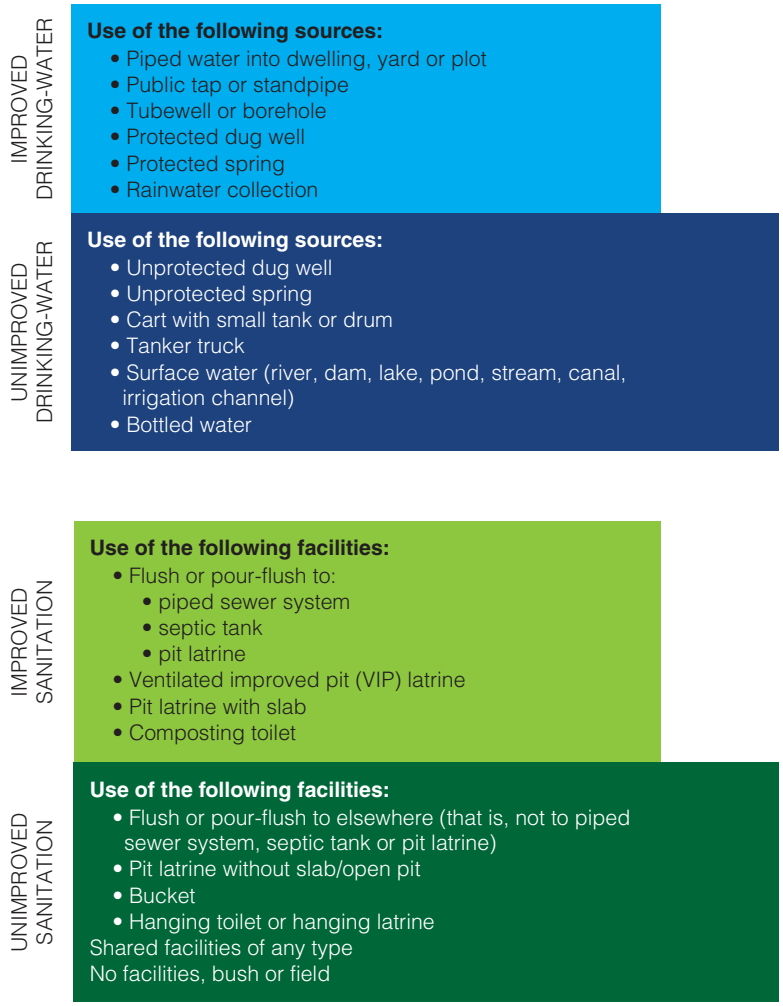
		Urban		Rural		National			
		Improved	Unimproved	Improved	Unimproved	Improved	Unimproved		
Country	Year	Total improved (%)	Open defecation (%)	Total improved (%)	Open defecation (%)	Total improved (%)	Open defecation (%)	Progress towards MDG target	2015 Pop. that gained access since 1990 (%)
Democratic Republic of the Congo	1990	30.0	4.0	14.4	19.1	19.2	14.5		
	1991	30.0	4.0	14.4	19.1	19.2	14.4		
	1992	30.0	4.0	14.4	19.1	19.3	14.4		
	1993	30.0	4.0	14.4	19.1	19.4	14.3		
	1994	29.9	3.9	15.0	19.0	19.9	14.1		
	1995	29.9	3.9	15.7	18.8	20.3	13.9		
	1996	29.8	3.8	16.3	18.7	20.8	13.7		
	1997	29.7	3.7	17.0	18.5	21.3	13.5		
	1998	29.7	3.7	17.6	18.4	21.8	13.3		
	1999	29.6	3.6	18.3	18.2	22.2	13.1		
	2000	29.5	3.5	18.9	18.1	22.7	13.0		
	2001	29.5	3.5	19.6	17.9	23.1	12.8		
	2002	29.4	3.4	20.3	17.8	23.5	12.6	Limited or no progress	19

table continues next page

Table E.2: continued

Country	Year	Urban		Rural		National		Progress towards MDG target	2015 Pop. that gained access since 1990 (%)
		Improved	Unimproved	Improved	Unimproved	Improved	Unimproved		
		Total improved (%)	Open defecation (%)	Total improved (%)	Open defecation (%)	Total improved (%)	Open defecation (%)		
	2003	29.3	3.3	20.9	17.6	24.0	12.4		
	2004	29.3	3.3	21.6	17.5	24.4	12.2		
	2005	29.2	3.2	22.2	17.3	24.8	12.0		
	2006	29.1	3.1	22.9	17.2	25.2	11.8		
	2007	29.1	3.1	23.5	17.0	25.6	11.7		
	2008	29.0	3.0	24.2	16.9	26.0	11.5		
	2009	28.9	2.9	24.8	16.7	26.4	11.3		
	2010	28.9	2.9	25.5	16.6	26.8	11.1		
	2011	28.8	2.8	26.1	16.4	27.2	10.9		
	2012	28.7	2.7	26.8	16.3	27.6	10.7		
	2013	28.7	2.7	27.4	16.1	27.9	10.5		
	2014	28.6	2.6	28.1	16.0	28.3	10.4		
	2015	28.5	2.5	28.7	15.8	28.7	10.2		

Figure E.1: JMP Definitions of “Improved” and “Unimproved”



Source: https://www.wssinfo.org/.

Appendix F Determinants of Household Access

Table F.1: Logistic Regressions of Access on Key Determinants

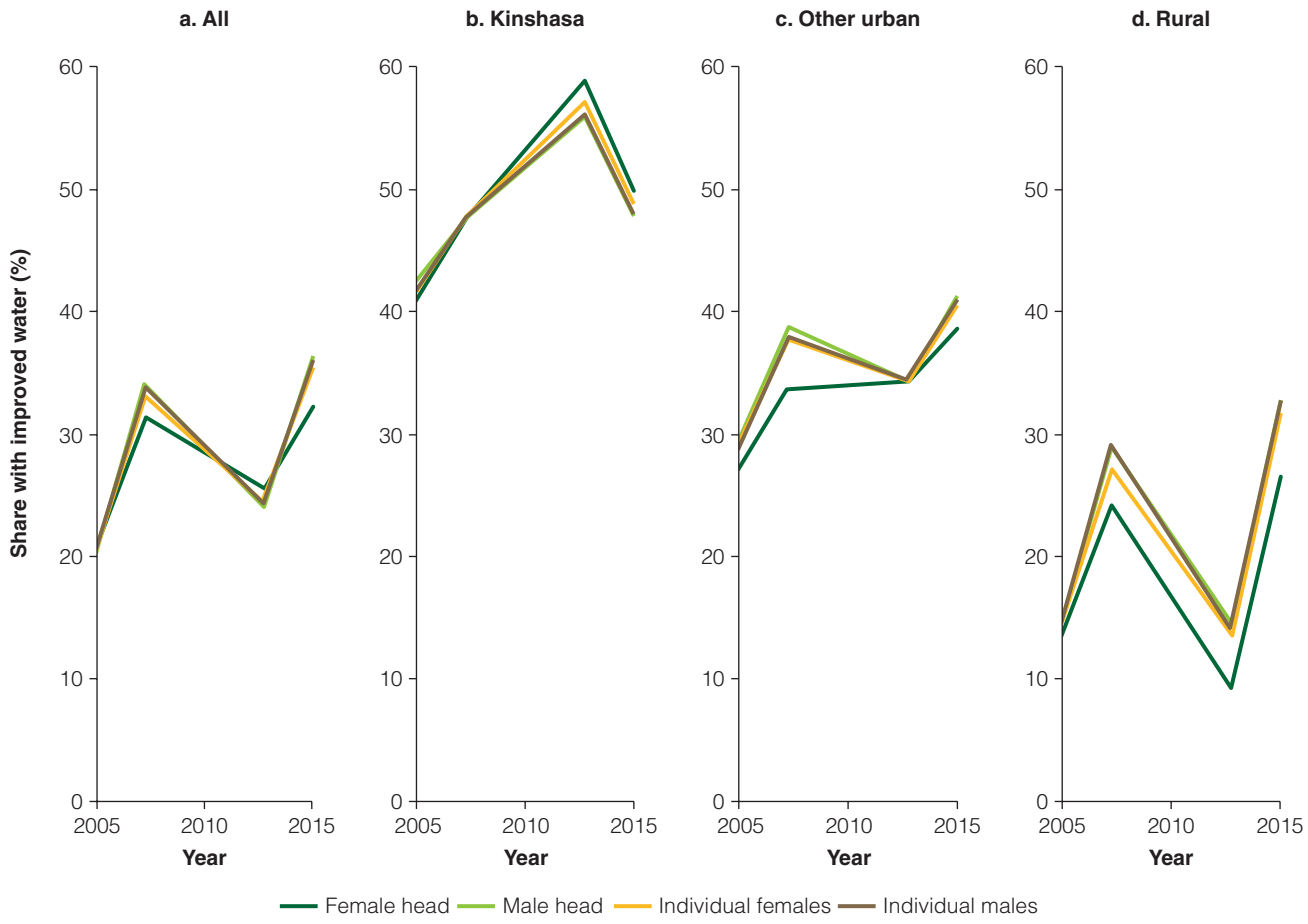
Variables	Improved water (2012)	Improved water (2005)	Improved sanitation (2012)	Improved sanitation (2005)
Below poverty line	–0.430***	–0.40**	–0.58***	–0.26**
Urban	2.13***	2.01***	1.2***	0.77***
Kinshasa	2.93***	1.81***	0.29	0.17
Completed primary education	–0.044	0.06	0.14	–0.1
Completed secondary education	–0.67	0.08	0.08	0.09
Tertiary education	0.40**	0.41**	0.78***	0.91***
Household size	0.043**	0.01	0.08***	0.04***

Source: World Bank calculation QUIBB 2005, and Enquête 123 2012.
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure F.1: Access to Improved Water, by Gender

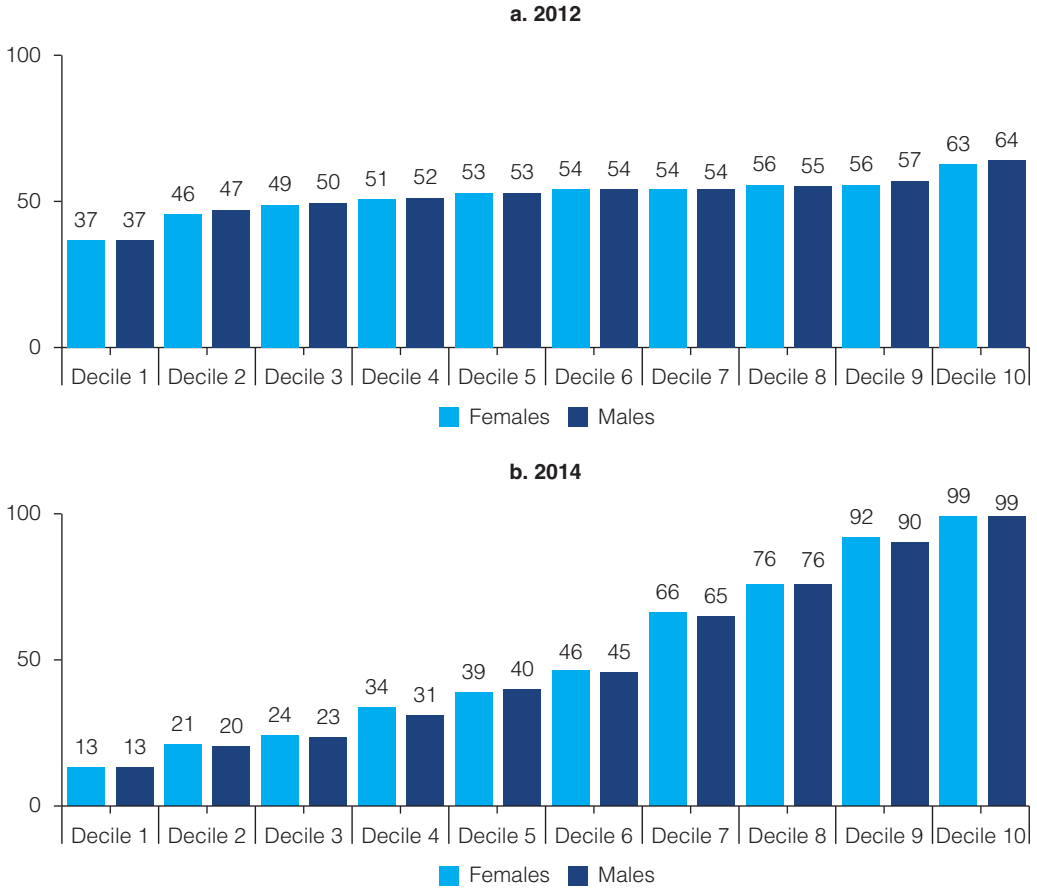
Source: DHS 2014, 2007; LSMS 2012, 2005.

Figure F.2: Access to Improved Sanitation, by Gender



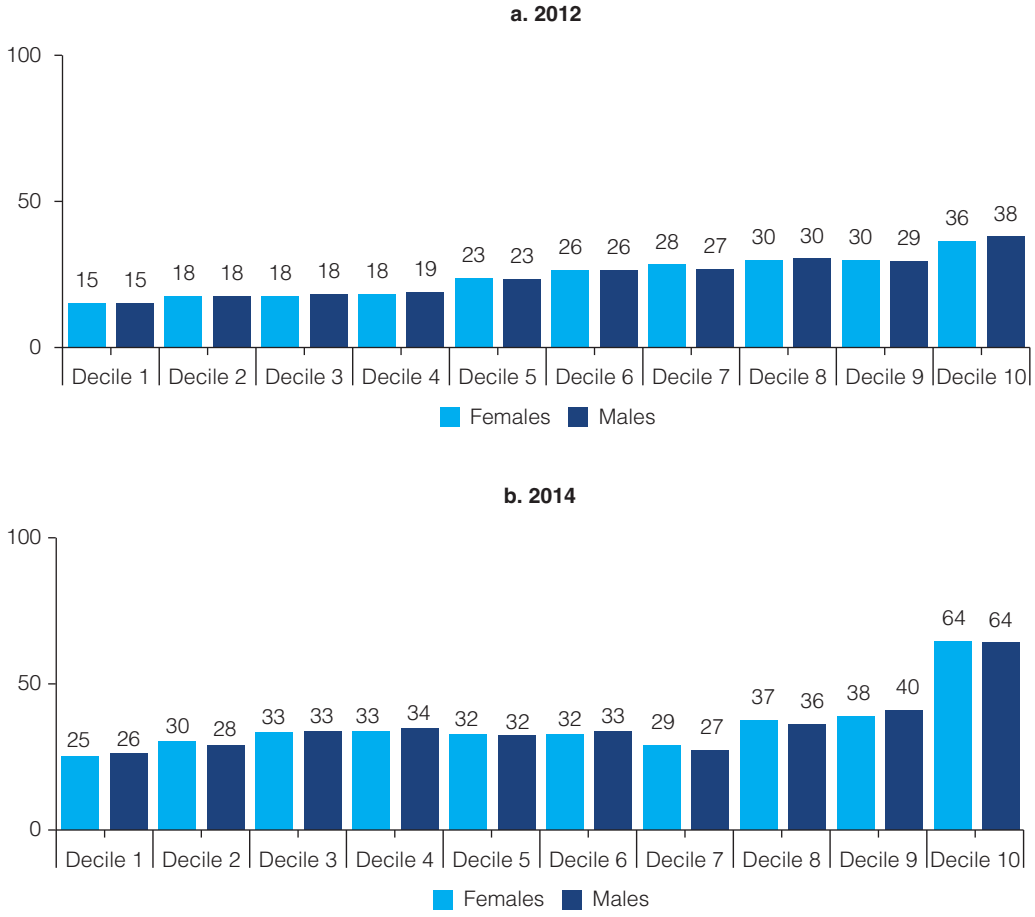
Source: DHS 2014, 2007; LSMS 2012, 2005.
Note: Sanitation is adjusted for shared by the average of the % of improved toilets that are shared across years by urban and rural.

Figure F.3: Improved Water, by Gender and Wealth (2014) or Expenditure (2012) Decile



Source: DHS 2014; LSMS 2012.
Note: DHS 2014 deciles are based on a wealth index while LSMS 2012 deciles are based on per capita expenditure. Females and Males are individuals.

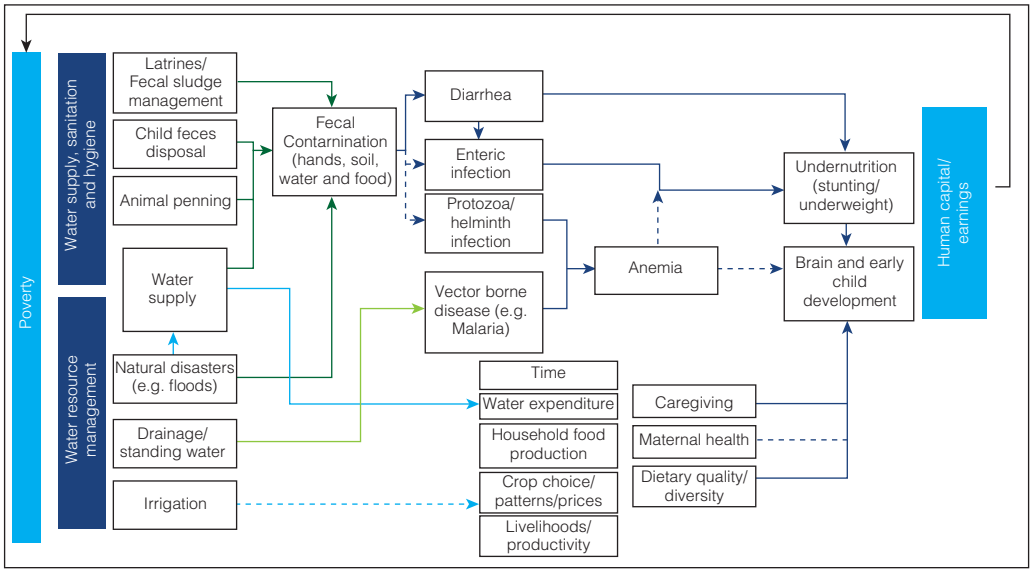
Figure F.4: Improved Sanitation, by Gender and Wealth (2014) or Expenditure (2012) Decile



Source: DHS 2014; LSMS 2012.
Note: DHS 2014 deciles are based on a wealth index while LSMS 2012 deciles are based on per capita expenditure. Females and Males are individuals. Sanitation is adjusted for shared by the average of the % of improved toilets that are shared across years by urban and rural.

Appendix G
Water, Sanitation, and Nutrition Pathways

Figure G.1: Overview of Water, Sanitation, and Nutrition Pathways



Source: Chase and Ngure 2016.

Appendix H
Stunting, Anthropometric Failures, and Unimproved Access

Table H.1: Regression Results: Stunting, Anthropometric Failures, and Unimproved Access

	(1)	(2)	(3)	(4)
Variables	Stunting	CIAF	Stunting (0–24 months)	Stunting (25–59 months)
Unimproved water (hh)	0.0819	0.0233	−0.0934	0.202*
	(0.0951)	(0.0995)	(0.138)	(0.112)
Unimproved sanitation (hh)	0.0914	0.114	0.301**	−0.0177
	(0.103)	(0.0960)	(0.148)	(0.124)
Breastfeeding (months)	−0.00309*	−0.00279*	−8.56e−05	−0.00714**
	(0.00174)	(0.00165)	(0.00220)	(0.00314)
Mother educ.	−0.143*	−0.176**	−0.194*	−0.115
	(0.0752)	(0.0777)	(0.116)	(0.0907)
age	0.119***	0.0847***	0.122***	0.0719
	(0.0125)	(0.0108)	(0.0444)	(0.0465)
Age^2	−0.00132***	−0.000906***	−0.000998	−0.000704
	(0.000167)	(0.000152)	(0.00189)	(0.000558)
girl	−0.218***	−0.284***	−0.378***	−0.126
	(0.0666)	(0.0668)	(0.110)	(0.0852)
rural	−0.0421	−0.182	−0.174	0.0518
	(0.116)	(0.114)	(0.169)	(0.128)
Wealth index	−0.227***	−0.211***	−0.155***	−0.275***
	(0.0332)	(0.0313)	(0.0433)	(0.0396)
New provinces	0.0315***	0.0260***	0.0436***	0.0239***
	(0.00574)	(0.00545)	(0.00807)	(0.00602)
Constant	−2.353***	−1.217***	−2.443***	−1.263
	(0.290)	(0.270)	(0.387)	(0.904)
Observations	7,941	7,941	3,521	4,420

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Wealth index has been rebuilt to exclude WASH variables.
hh denotes that the WASH variable is at the household level.

Appendix I
Stunting, Improved Sanitation, and Water Versus Open Defecation

Table I.1: Regression Results: Stunting, Improved Sanitation, and Water Versus Open Defecation

	(1)	(2)	(3)	(4)
Variables	Stunt	Stunt	Stunt	Stunt
Unimproved water	0.0920		0.0544	
	(0.0966)		(0.103)	
Improved sanitation (hh)	−0.192*	−0.192*		
	(0.100)	(0.100)		
Improved sanitation (cty)	0.788***	0.788***		
	(0.254)	(0.254)		
Breastfeeding (month)	−0.00304*	−0.00304*	−0.00320*	−0.00320*
	(0.00172)	(0.00172)	(0.00176)	(0.00176)
Mother educ.	−0.144*	−0.144*	−0.146*	−0.146*
	(0.0751)	(0.0751)	(0.0753)	(0.0753)
age	0.118***	0.118***	0.119***	0.119***
	(0.0123)	(0.0123)	(0.0126)	(0.0126)
Age^2	−0.00131***	−0.00131***	−0.00132***	−0.00132***
	(0.000164)	(0.000164)	(0.000168)	(0.000168)
girl	−0.220***	−0.220***	−0.215***	−0.215***
	(0.0687)	(0.0687)	(0.0687)	(0.0687)
rural	−0.0479	−0.0479	−0.0303	−0.0303
	(0.112)	(0.112)	(0.116)	(0.116)
Wealth index	−0.236***	−0.236***	−0.236***	−0.236***
	(0.0316)	(0.0316)	(0.0320)	(0.0320)
New Provinces	0.0296***	0.0296***	0.0313***	0.0313***
	(0.00582)	(0.00582)	(0.00571)	(0.00571)
Improved water (hh)		−0.0920		−0.0544
		(0.0966)		(0.103)

table continues next page

Table I.1: continued

Variables	(1) Stunt	(2) Stunt	(3) Stunt	(4) Stunt
OD (hh)			0.107	0.107
			(0.127)	(0.127)
OD (cty)			0.0502	0.0502
			(0.131)	(0.131)
Constant	−2.239***	−2.147***	−2.308***	−2.254***
	(0.281)	(0.245)	(0.282)	(0.259)
Observations	7,851	7,851	7,851	7,851

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
hh denotes that the WASH variable is at the household level while cty indicates that the variable is at the community level (i.e. that at least 75 percent of the household of the cluster/ community rely on said type of access); in the case of Open Defecation (OD) the cluster/community variable is defined as 20 percent of more of the households relying on OD.

Appendix J
Improved WASH Access, CIAF, and Under-Five Children (0–59 Months)

Table J.1: Regression Results: Improved WASH Access, CIAF, and Children under Five

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	stunt	stunt	stunt	stunt	stunt	stunt
water	−0.0720				−0.0691	
	(0.0966)				(0.0954)	
months_BF	−0.00319*	−0.00317*	−0.00323*	−0.00313*	−0.00326*	−0.00324*
	(0.00176)	(0.00177)	(0.00177)	(0.00177)	(0.00176)	(0.00177)
mom_edu	−0.151**	−0.151**	−0.150**	−0.152**	−0.147*	−0.147*
	(0.0750)	(0.0750)	(0.0753)	(0.0750)	(0.0755)	(0.0755)
age	0.119***	0.119***	0.119***	0.119***	0.120***	0.119***
	(0.0126)	(0.0127)	(0.0127)	(0.0127)	(0.0125)	(0.0126)
age2	−0.00131***	−0.00131***	−0.00131***	−0.00131***	−0.00132***	−0.00132***
	(0.000167)	(0.000168)	(0.000168)	(0.000168)	(0.000166)	(0.000166)
girl	−0.217***	−0.215***	−0.217***	−0.216***	−0.217***	−0.216***
	(0.0685)	(0.0684)	(0.0687)	(0.0688)	(0.0685)	(0.0685)
rural	−0.0443	−0.0736	−0.0610	−0.0695	−0.0478	−0.0758
	(0.116)	(0.114)	(0.111)	(0.109)	(0.117)	(0.115)
wealth_ind_	−0.237***	−0.249***	−0.248***	−0.245***	−0.237***	−0.249***
own	(0.0319)	(0.0322)	(0.0307)	(0.0341)	(0.0320)	(0.0324)
snprovin	0.0307***	0.0291***	0.0292***	0.0298***	0.0307***	0.0292***
	(0.00584)	(0.00567)	(0.00557)	(0.00553)	(0.00582)	(0.00564)
water_basic		0.0497				0.0492
		(0.0998)				(0.0992)
water_dist			0.0604			
			(0.0811)			
water_safe				0.0379		
				(0.218)		
toilet					−0.106	−0.107
					(0.104)	(0.104)
toilet_com						
watersf_com						
Constant	−2.187***	−2.176***	−2.218***	−2.176***	−2.173***	−2.163***
	(0.248)	(0.249)	(0.245)	(0.248)	(0.252)	(0.252)
Observations	7,851	7,805	7,806	7,851	7,851	7,805

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

(7)	(8)	(9)	(10)	(11)	(12)	(13)
stunt	stunt	stunt	stunt	stunt	stunt	stunt
		−0.0928				
		(0.0976)				
−0.00330*	−0.00320*	−0.00298*	−0.00296*	−0.00301*	−0.00291*	−0.00296*
(0.00177)	(0.00177)	(0.00172)	(0.00174)	(0.00174)	(0.00173)	(0.00175)
−0.147*	−0.148**	−0.150**	−0.151**	−0.151**	−0.152**	−0.148**
(0.0758)	(0.0755)	(0.0747)	(0.0748)	(0.0750)	(0.0747)	(0.0747)
0.120***	0.119***	0.118***	0.117***	0.117***	0.117***	0.118***
(0.0126)	(0.0125)	(0.0124)	(0.0125)	(0.0125)	(0.0125)	(0.0126)
−0.00132***	−0.00132***	−0.00130***	−0.00129***	−0.00130***	−0.00130***	−0.00132***
(0.000166)	(0.000166)	(0.000165)	(0.000166)	(0.000166)	(0.000166)	(0.000169)
−0.217***	−0.216***	−0.219***	−0.218***	−0.219***	−0.218***	−0.218***
(0.0687)	(0.0688)	(0.0685)	(0.0685)	(0.0688)	(0.0689)	(0.0667)
−0.0634	−0.0720	−0.0418	−0.0744	−0.0657	−0.0740	−0.0728
(0.112)	(0.110)	(0.113)	(0.111)	(0.106)	(0.105)	(0.110)
−0.247***	−0.244***	−0.237***	−0.249***	−0.249***	−0.246***	−0.228***
(0.0307)	(0.0342)	(0.0317)	(0.0320)	(0.0306)	(0.0342)	(0.0327)
0.0293***	0.0298***	0.0298***	0.0281***	0.0281***	0.0286***	0.0303***
(0.00554)	(0.00550)	(0.00586)	(0.00568)	(0.00559)	(0.00555)	(0.00543)
			0.0321			
			(0.100)			
0.0583				0.0564		
(0.0814)				(0.0814)		
	0.0342				0.0383	
	(0.217)				(0.217)	
−0.105	−0.108					
(0.104)	(0.104)					
		0.649***	0.620**	0.624**	0.625**	
		(0.245)	(0.249)	(0.244)	(0.250)	
						−0.291
						(0.361)
−2.204***	−2.162***	−2.174***	−2.162***	−2.200***	−2.160***	−2.167***
(0.249)	(0.251)	(0.243)	(0.244)	(0.240)	(0.243)	(0.246)
7,806	7,851	7,851	7,805	7,806	7,851	7,942

Appendix K
Improved WASH Access, CIAF, and Younger Children (0–24 Months)

Table K.1: Regression Results: Improved WASH Access, CIAF, and Younger Children (0–24 Months)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all
Improved water	0.217				0.228	
	(0.142)				(0.141)	
Breastfeeding (months)	−0.00157	−0.00157	−0.00182	−0.00178	−0.00166	−0.00166
	(0.00195)	(0.00194)	(0.00194)	(0.00195)	(0.00193)	(0.00192)
Edu mother	−0.259**	−0.250**	−0.243**	−0.252**	−0.253**	−0.243**
	(0.104)	(0.105)	(0.106)	(0.104)	(0.105)	(0.106)
age	0.0450	0.0465*	0.0451*	0.0434	0.0481*	0.0494*
	(0.0276)	(0.0276)	(0.0274)	(0.0273)	(0.0278)	(0.0278)
Age^2	0.000975	0.000918	0.000985	0.00106	0.000905	0.000852
	(0.00116)	(0.00116)	(0.00114)	(0.00114)	(0.00116)	(0.00116)
girl	−0.417***	−0.420***	−0.430***	−0.424***	−0.420***	−0.423***
	(0.0982)	(0.0993)	(0.0992)	(0.0982)	(0.0986)	(0.0997)
rural	−0.382**	−0.399**	−0.311**	−0.310**	−0.387**	−0.400**
	(0.170)	(0.171)	(0.153)	(0.151)	(0.168)	(0.170)
Wealth Index	−0.142***	−0.158***	−0.136***	−0.141***	−0.142***	−0.157***
	(0.0412)	(0.0390)	(0.0404)	(0.0461)	(0.0415)	(0.0393)
New provinces	0.0298***	0.0287***	0.0312***	0.0333***	0.0301***	0.0292***
	(0.00826)	(0.00778)	(0.00856)	(0.00857)	(0.00817)	(0.00769)
Basic Water		0.369**				0.366**
		(0.175)				(0.173)
Improved Water w/in 30 min			0.212*			
			(0.126)			
“Safe” water				0.287		
				(0.259)		
Improved san					−0.309**	−0.298**
					(0.150)	(0.148)
Improved san_co						
Constant	−0.768***	−0.763***	−0.915***	−0.812***	−0.742***	−0.740***
	(0.275)	(0.278)	(0.272)	(0.276)	(0.276)	(0.279)
Observations	3,469	3,452	3,453	3,469	3,469	3,452

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

(7)	(8)	(9)	(10)	(11)	(12)
ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all
		0.180			
		(0.142)			
−0.00191	−0.00187	−0.00133	−0.00133	−0.00154	−0.00187
(0.00192)	(0.00192)	(0.00194)	(0.00194)	(0.00193)	(0.00192)
−0.237**	−0.246**	−0.260**	−0.251**	−0.245**	−0.246**
(0.107)	(0.105)	(0.104)	(0.105)	(0.106)	(0.105)
0.0480*	0.0462*	0.0420	0.0436	0.0423	0.0462*
(0.0275)	(0.0275)	(0.0278)	(0.0279)	(0.0276)	(0.0275)
0.000920	0.000996	0.00104	0.000981	0.00104	0.000996
(0.00115)	(0.00115)	(0.00117)	(0.00117)	(0.00115)	(0.00115)
−0.433***	−0.426***	−0.424***	−0.426***	−0.436***	−0.426***
(0.0996)	(0.0987)	(0.0978)	(0.0988)	(0.0988)	(0.0987)
−0.313**	−0.312**	−0.379**	−0.402**	−0.322**	−0.312**
(0.154)	(0.151)	(0.168)	(0.172)	(0.151)	(0.151)
−0.134***	−0.139***	−0.139***	−0.156***	−0.136***	−0.139***
(0.0405)	(0.0461)	(0.0412)	(0.0388)	(0.0405)	(0.0461)
0.0317***	0.0337***	0.0288***	0.0275***	0.0297***	0.0337***
(0.00842)	(0.00843)	(0.00828)	(0.00784)	(0.00867)	(0.00843)
			0.340*		
			(0.181)		
0.207*				0.205	
(0.126)				(0.125)	
	0.280				0.280
	(0.258)				(0.258)
−0.297**	−0.298**				−0.298**
(0.151)	(0.152)				(0.152)
		1.092***	1.077***	1.133***	
		(0.339)	(0.370)	(0.358)	
−0.889***	−0.788***	−0.744***	−0.736***	−0.882***	−0.788***
(0.275)	(0.277)	(0.267)	(0.271)	(0.261)	(0.277)
3,453	3,469	3,469	3,452	3,453	3,469

Appendix L
Improved WASH Access, CIAF, and Older Children (25–59 Months)

Table L.1: Regression Results: Improved WASH Access, CIAF, and Older Children (25–59 Months)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all
water	−0.192				−0.193	
	(0.118)				(0.117)	
months_BF	−0.00618*	−0.00605*	−0.00577*	−0.00594*	−0.00618*	−0.00605*
	(0.00324)	(0.00326)	(0.00327)	(0.00325)	(0.00324)	(0.00326)
mom_edu	−0.131	−0.133	−0.131	−0.135	−0.131	−0.133
	(0.0982)	(0.0977)	(0.0967)	(0.0972)	(0.0987)	(0.0981)
age	0.0923*	0.0925*	0.0899*	0.0904*	0.0922*	0.0925*
	(0.0472)	(0.0473)	(0.0475)	(0.0473)	(0.0471)	(0.0472)
age2	−0.000942*	−0.000943*	−0.000912	−0.000922	−0.000941*	−0.000943*
	(0.000566)	(0.000568)	(0.000571)	(0.000568)	(0.000565)	(0.000567)
girl	−0.188**	−0.191**	−0.187**	−0.185**	−0.188**	−0.191**
	(0.0865)	(0.0872)	(0.0879)	(0.0875)	(0.0865)	(0.0872)
rural	−0.0322	−0.0490	−0.0933	−0.102	−0.0319	−0.0490
	(0.133)	(0.131)	(0.130)	(0.128)	(0.132)	(0.131)
wealth_ind_own	−0.283***	−0.284***	−0.295***	−0.299***	−0.283***	−0.284***
	(0.0391)	(0.0398)	(0.0377)	(0.0441)	(0.0392)	(0.0400)
snprovin	0.0215***	0.0209***	0.0199***	0.0192***	0.0215***	0.0209***
	(0.00614)	(0.00608)	(0.00587)	(0.00580)	(0.00614)	(0.00608)
water_basic		−0.189				−0.189
		(0.115)				(0.115)
water_dist			−0.128			
			(0.0868)			
water_safe				0.0185		
				(0.274)		
toilet					0.00545	0.00107
					(0.114)	(0.114)
toilet_com						
Constant	−1.205	−1.220	−1.101	−1.150	−1.205	−1.220
	(0.878)	(0.882)	(0.894)	(0.882)	(0.878)	(0.882)
Observations	4,382	4,353	4,353	4,382	4,382	4,353

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

(7)	(8)	(9)	(10)	(11)	(12)
ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all	ciaf_all
		−0.209*			
		(0.119)			
−0.00577*	−0.00594*	−0.00598*	−0.00584*	−0.00555*	−0.00594*
(0.00327)	(0.00325)	(0.00322)	(0.00323)	(0.00325)	(0.00325)
−0.130	−0.135	−0.132	−0.134	−0.131	−0.135
(0.0971)	(0.0976)	(0.0982)	(0.0976)	(0.0966)	(0.0976)
0.0899*	0.0903*	0.0908*	0.0911*	0.0884*	0.0903*
(0.0474)	(0.0472)	(0.0473)	(0.0474)	(0.0476)	(0.0472)
−0.000912	−0.000921	−0.000925	−0.000926	−0.000895	−0.000921
(0.000570)	(0.000566)	(0.000568)	(0.000570)	(0.000572)	(0.000566)
−0.187**	−0.185**	−0.189**	−0.192**	−0.188**	−0.185**
(0.0879)	(0.0875)	(0.0865)	(0.0873)	(0.0879)	(0.0875)
−0.0934	−0.102	−0.0276	−0.0482	−0.0951	−0.102
(0.130)	(0.128)	(0.130)	(0.128)	(0.127)	(0.128)
−0.295***	−0.299***	−0.283***	−0.284***	−0.296***	−0.299***
(0.0379)	(0.0443)	(0.0389)	(0.0396)	(0.0377)	(0.0443)
0.0199***	0.0192***	0.0206***	0.0200***	0.0188***	0.0192***
(0.00587)	(0.00579)	(0.00611)	(0.00606)	(0.00586)	(0.00579)
			−0.202*		
			(0.114)		
−0.128				−0.130	
(0.0872)				(0.0869)	
	0.0185				0.0185
	(0.274)				(0.274)
−0.00259	0.00116				0.00116
(0.114)	(0.114)				(0.114)
		0.583**	0.571**	0.540*	
		(0.269)	(0.285)	(0.279)	
−1.101	−1.150	−1.191	−1.204	−1.083	−1.150
(0.894)	(0.881)	(0.879)	(0.884)	(0.896)	(0.881)
4,353	4,382	4,382	4,353	4,353	4,382

Appendix M
Anemia and WASH Access of Children (6–59 Months)

Table M.1: Regression Results: Anemia and WASH Access of Children

	(1)	(2)	(3)
Variables	anemia	anemia	stunt
Unimproved water	0.251*		
	(0.140)		
Unimproved sanitation	–0.132		
	(0.117)		
opendef	0.403***		
	(0.120)		
mom_edu	–0.0851	–0.0936	–0.150**
	(0.0824)	(0.0840)	(0.0747)
age	–0.0211**	–0.0201**	0.117***
	(0.00896)	(0.00878)	(0.0124)
age2	6.17e–05	5.01e–05	–0.00130***
	(0.000137)	(0.000135)	(0.000165)
girl	–0.00850	–0.0167	–0.220***
	(0.0743)	(0.0741)	(0.0686)
rural	0.201	0.173	–0.0465
	(0.167)	(0.168)	(0.113)
Wealth Index	–0.0915***	–0.0948***	–0.231***
	(0.0320)	(0.0320)	(0.0330)
Iron suppl	–0.0376	–0.0325	
	(0.0540)	(0.0557)	
Impr Water		–0.286*	–0.0927
		(0.147)	(0.0976)
Impr San cluster level		–0.863***	0.660***
		(0.292)	(0.250)
Interaction improved Water*San		0.649	
		(0.427)	
Safe Water cluster level			–0.268
			(0.332)

table continues next page

Table M.1: continued

Variables	(1) anemia	(2) anemia	(3) stunt
Breastfeeding (months)			–0.00295* (0.00172)
New provinces			0.0297*** (0.00587)
Constant	–0.340 (0.311)	–0.0903 (0.239)	–2.164*** (0.244)
Observations	7,183	7,183	7,851

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Anemia testing is not done for children below 6 months of age.

Appendix N
Malaria and WASH Access of Children (6–59 Months)

Table N.1: Regression Results: Malaria and WASH Access of Children (6–59 months)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	malaria	malaria	malaria	malaria	malaria	malaria
water_unimpr	0.356**	0.270*				
	(0.149)	(0.148)				
unimpr_san	0.137		0.164			
	(0.174)		(0.182)			
Bed nets	−0.322***	−0.329***	−0.318***	−0.318***	−0.315***	−0.314***
	(0.0980)	(0.0983)	(0.0987)	(0.0987)	(0.0991)	(0.0981)
months_BF	0.00474**	0.00475**	0.00473**	0.00473**	0.00460**	0.00481**
	(0.00192)	(0.00196)	(0.00193)	(0.00193)	(0.00191)	(0.00189)
mom_edu	−0.194**	−0.190**	−0.188*	−0.188*	−0.196**	−0.210**
	(0.0958)	(0.0964)	(0.0973)	(0.0973)	(0.0991)	(0.0988)
age	0.0336*	0.0339*	0.0354**	0.0354**	0.0360**	0.0329*
	(0.0173)	(0.0175)	(0.0174)	(0.0174)	(0.0173)	(0.0173)
age2	−0.000347	−0.000349	−0.000377*	−0.000377*	−0.000381*	−0.000338
	(0.000227)	(0.000229)	(0.000227)	(0.000227)	(0.000227)	(0.000228)
girl	0.0236	0.0299	0.0366	0.0366	0.0391	0.0240
	(0.0792)	(0.0801)	(0.0800)	(0.0800)	(0.0797)	(0.0779)
rural	0.364**	0.498***	0.356*	0.356*	0.363*	0.408**
	(0.183)	(0.192)	(0.185)	(0.185)	(0.188)	(0.190)
wealth_ind_own	−0.171***	−0.171***	−0.173***	−0.173***	−0.174***	−0.164***
	(0.0436)	(0.0435)	(0.0452)	(0.0452)	(0.0448)	(0.0439)
snprovin	0.0123	0.0164*	0.0130	0.0130	0.0141	0.0144
	(0.00954)	(0.00952)	(0.00968)	(0.00968)	(0.00997)	(0.0100)
opendef_com		0.609***				
		(0.165)				
water			−0.363**	−0.363**	−0.350**	
			(0.153)	(0.153)	(0.152)	
toilet				−0.164		
				(0.182)		

table continues next page

Table N.1: continued

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	malaria	malaria	malaria	malaria	malaria	malaria
toilet_com					−0.786	−0.798
					(0.851)	(0.851)
water_com						−0.427**
						(0.203)
Constant	−2.946***	−3.196***	−2.647***	−2.483***	−2.527***	−2.545***
	(0.443)	(0.419)	(0.390)	(0.333)	(0.339)	(0.341)
Observations	7,130	7,130	7,060	7,060	7,060	7,131

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix O
Stunting, Improved Sanitation, and Water in Kinshasa

Table O.1: Regression Results: Stunting, Improved Sanitation, and Water in Kinshasa

	(1)	(2)	(3)	(4)
Variables	Stunting	CIAF	Stunting (0–24 months)	Stunting (25–59 months)
Improved water (tier 3)	−0.043*	−0.067	−0.019	−0.056
	(0.024)	(0.044)	(0.021)	(0.042)
Improved sanitation	−0.017	−0.053*	0.031	−0.065**
	(0.036)	(0.027)	(0.051)	(0.027)
Lack food in last 12 months	0.005	0.001	−0.021	0.030
	(0.026)	(0.029)	(0.029)	(0.036)
No. of children under 5	0.036**	0.034**	0.035**	0.037*
	(0.015)	(0.016)	(0.014)	(0.019)
Household size	−0.009*	−0.003	−0.006	−0.010*
	(0.005)	(0.008)	(0.006)	(0.006)
Female head	−0.009	−0.016	0.004	−0.015
	(0.021)	(0.023)	(0.019)	(0.038)
Head education (years)	0.003	0.004	0.005	0.002
	(0.003)	(0.004)	(0.006)	(0.005)
Girl	−0.026	−0.019	−0.009	−0.036*
	(0.020)	(0.023)	(0.024)	(0.021)
Age (months)	0.009***	0.002	0.019***	0.201***
	(0.003)	(0.003)	(0.004)	(0.041)
Age (months) square	−0.000***	−0.000	−0.001***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Diarrhea	0.060***	0.057***	0.029	0.106***
	(0.021)	(0.018)	(0.033)	(0.038)
Wealth index	−0.008***	−0.005	−0.015**	−0.003
	(0.003)	(0.004)	(0.007)	(0.007)
Observations	931	930	437	494

Note: Gray shading designates key WASH-related variables. Standard errors clustered at commune level in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Wealth index has been rebuilt to exclude WASH variables, results using the SWIFT are similar.
WASH variables are at household level.
Results shown are the marginal effects of Probit regression.

Appendix P
Improved WASH Access and Stunting of Under-Five Children (0–59 Months) in Kinshasa

Table P.1: Regression Results: Improved WASH Access and Stunting of Children under Five in Kinshasa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	stunt	stunt	stunt	stunt	stunt	stunt	stunt	stunt	stunt
Lack food in last 12 months	0.016 (0.023)	0.016 (0.022)	0.006 (0.026)	0.014 (0.023)	0.015 (0.023)	0.005 (0.026)	0.000 (0.027)	0.003 (0.028)	−0.000 (0.027)
No. of children under 5	0.032*** (0.009)	0.032*** (0.010)	0.036** (0.015)	0.032*** (0.009)	0.032*** (0.009)	0.036** (0.015)	0.036** (0.016)	0.037** (0.015)	0.037** (0.016)
Household size	−0.006*** (0.002)	−0.006*** (0.002)	−0.009** (0.005)	−0.006*** (0.002)	−0.006*** (0.002)	−0.009* (0.005)	−0.010** (0.005)	−0.010** (0.005)	−0.010** (0.005)
Female head	0.016 (0.016)	0.017 (0.016)	−0.010 (0.021)	0.015 (0.017)	0.015 (0.017)	−0.009 (0.021)	−0.013 (0.020)	−0.011 (0.020)	−0.014 (0.020)
Head education (years)	0.001 (0.003)	0.001 (0.003)	0.003 (0.003)	0.001 (0.003)	0.001 (0.003)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)
Girl	−0.041** (0.018)	−0.041** (0.018)	−0.026 (0.020)	−0.042** (0.017)	−0.042** (0.017)	−0.026 (0.020)	−0.027 (0.020)	−0.025 (0.019)	−0.026 (0.019)
Age (months)	0.011*** (0.003)	0.011*** (0.003)	0.009*** (0.003)	0.011*** (0.003)	0.011*** (0.003)	0.009*** (0.003)	0.009*** (0.003)	0.009*** (0.003)	0.009*** (0.003)
Age (months) square	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)
Diarrhea	0.023** (0.011)	0.023** (0.011)	0.062*** (0.019)	0.020* (0.012)	0.020 (0.012)	0.060*** (0.021)	0.061*** (0.021)	0.058*** (0.021)	0.060*** (0.020)
Wealth index	−0.018*** (0.003)	−0.017*** (0.002)	−0.009*** (0.002)	−0.016*** (0.003)	−0.016*** (0.003)	−0.008*** (0.003)	−0.005 (0.005)	−0.008** (0.003)	−0.005 (0.005)
Water_basic (tier 1)	0.025 (0.027)			0.022 (0.026)					
Water_dist (tier 2)		−0.000 (0.020)			−0.003 (0.021)				
Water_safe (tier 3)			−0.042* (0.023)			−0.043* (0.024)	−0.029 (0.027)	−0.040* (0.023)	−0.029 (0.027)

table continues next page

Table P.1: continued

Variables	(1) stunt	(2) stunt	(3) stunt	(4) stunt	(5) stunt	(6) stunt	(7) stunt	(8) stunt	(9) stunt
Improved sanitation hh				−0.042	−0.043	−0.017	−0.020	−0.014	−0.017
				(0.036)	(0.037)	(0.036)	(0.037)	(0.035)	(0.036)
Water_safe (commune)							−0.102		−0.090
							(0.103)		(0.095)
Improved sanitation (commune)								−0.118	−0.068
								(0.132)	(0.111)
Observations	1,580	1,580	931	1,580	1,580	931	931	931	931

Note: Gray shading designates key WASH-related variables. Standard errors clustered at commune level in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Wealth index has been rebuilt to exclude WASH variables.
Results shown are the marginal effects of Probit regression.

Appendix Q
Anemia, Malaria, Stunting, WASH Access, and Conflict (Children 6–59 Months)

Table Q.1: Regression Results: Anemia, Malaria, Stunting, WASH Access, and Conflict (Children 6–59 Months)

	(1)	(2)	(3)	(4)
Variables	malaria	anemia	stunt	ciaf_all
water	−0.190	−0.144	−0.125	−0.0296
	(0.148)	(0.132)	(0.108)	(0.116)
toilet	−0.0993	0.0991	−0.105	−0.127
	(0.165)	(0.106)	(0.109)	(0.104)
Distance to HQ	0.00269***	0.00196***	−0.000653	−0.000345
	(0.000666)	(0.000493)	(0.000443)	(0.000424)
Breastfeeding duration	0.00358*	0.00152	−0.00252	−0.00215
	(0.00200)	(0.00146)	(0.00182)	(0.00169)
Mother edu	−0.233**	−0.140	−0.170**	−0.193**
	(0.0996)	(0.0866)	(0.0817)	(0.0828)
age	0.0456**	−0.0321**	0.115***	0.0771***
	(0.0184)	(0.0130)	(0.0131)	(0.0111)
age2	−0.000507**	0.000187	−0.00127***	−0.000800***
	(0.000242)	(0.000176)	(0.000175)	(0.000158)
girl	0.0769	0.0223	−0.185***	−0.259***
	(0.0835)	(0.0783)	(0.0709)	(0.0711)
rural	0.322*	0.144	−0.0160	−0.182
	(0.187)	(0.166)	(0.120)	(0.119)
wealth_ind_own	−0.127***	−0.0680**	−0.247***	−0.225***
	(0.0460)	(0.0340)	(0.0325)	(0.0309)
snprovin	0.0175*	0.00244	0.0290***	0.0245***
	(0.00990)	(0.00801)	(0.00592)	(0.00553)

table continues next page

Table Q.1: continued

Variables	(1)	(2)	(3)	(4)
	malaria	anemia	stunt	ciaf_all
nets	−0.379***			
	(0.0975)			
iron_supl		−0.00410		
		(0.0522)		
Constant	−3.003***	−0.314	−2.061***	−0.950***
	(0.368)	(0.274)	(0.264)	(0.216)
Observations	6,486	6,549	7,219	7,219

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix R
Anemia, Malaria, Stunting, WASH Access, and Conflict (Number of Events Year Prior to Survey, Children 6–59 Months)

Table R.1: Regression Results: Anemia, Malaria, Stunting, WASH Access, and Conflict

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	malaria	anemia	stunt	ciaf_all	malaria	anemia	stunt	ciaf_all
water	−0.326**	−0.249*	−0.0819	−0.00475	−0.321**	−0.245*	−0.0808	−0.00304
	(0.148)	(0.137)	(0.0975)	(0.103)	(0.148)	(0.137)	(0.0977)	(0.103)
toilet	−0.0637	0.126	−0.113	−0.131	−0.0624	0.125	−0.114	−0.132
	(0.174)	(0.112)	(0.114)	(0.108)	(0.174)	(0.112)	(0.114)	(0.108)
event_strat2012	−0.0593*	−0.0238***	−0.0101**	−0.0105**				
	(0.0342)	(0.00661)	(0.00493)	(0.00416)				
months_BF	0.00396*	0.00185	−0.00257	−0.00218	0.00390*	0.00183	−0.00258	−0.00219
	(0.00204)	(0.00146)	(0.00181)	(0.00168)	(0.00203)	(0.00147)	(0.00181)	(0.00167)
mom_edu	−0.213**	−0.125	−0.170**	−0.191**	−0.216**	−0.125	−0.171**	−0.191**
	(0.102)	(0.0852)	(0.0823)	(0.0834)	(0.101)	(0.0852)	(0.0821)	(0.0832)
age	0.0412**	−0.0349***	0.115***	0.0767***	0.0417**	−0.0347***	0.115***	0.0768***
	(0.0185)	(0.0131)	(0.0131)	(0.0112)	(0.0185)	(0.0131)	(0.0131)	(0.0112)
age2	−0.000454*	0.000219	−0.00126***	−0.000792***	−0.000459*	0.000217	−0.00126***	−0.000792***
	(0.000243)	(0.000175)	(0.000176)	(0.000160)	(0.000243)	(0.000175)	(0.000176)	(0.000160)
girl	0.0704	0.0169	−0.183***	−0.259***	0.0723	0.0179	−0.183***	−0.258***
	(0.0843)	(0.0792)	(0.0710)	(0.0715)	(0.0840)	(0.0791)	(0.0709)	(0.0714)
rural	0.486***	0.251	0.0151	−0.145	0.452**	0.244	0.00674	−0.151
	(0.187)	(0.169)	(0.116)	(0.113)	(0.183)	(0.167)	(0.118)	(0.114)
wealth_ind_own	−0.136***	−0.0869**	−0.230***	−0.213***	−0.149***	−0.0915***	−0.233***	−0.215***
	(0.0476)	(0.0340)	(0.0335)	(0.0330)	(0.0461)	(0.0338)	(0.0328)	(0.0324)
snprovin	0.0136	−0.000350	0.0324***	0.0272***	0.0144	0.000582	0.0325***	0.0275***
	(0.00966)	(0.00825)	(0.00609)	(0.00581)	(0.00975)	(0.00834)	(0.00613)	(0.00584)
nets	−0.366***				−0.362***			
	(0.100)				(0.100)			
iron_supl		−0.00167				0.00235		
		(0.0622)				(0.0632)		
event_civ2012					−0.0701	−0.0332***	−0.0110**	−0.0125***
					(0.0459)	(0.00744)	(0.00496)	(0.00376)
Constant	−2.638***	−0.0612	−2.229***	−1.068***	−2.628***	−0.0701	−2.224***	−1.068***
	(0.346)	(0.262)	(0.258)	(0.209)	(0.346)	(0.261)	(0.259)	(0.210)
Observations	6,486	6,549	7,219	7,219	6,486	6,549	7,219	7,219

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix S
Anemia, Malaria, Stunting, WASH Access, and Conflict (Causalities, Children 6–59 Months)

Table S.1: Regression Results: Anemia, Malaria, Stunting, WASH Access, and Conflict (Causalities, Children 6–59 Months)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	malaria	anemia	stunt	ciaf_all	malaria	anemia	stunt
water	−0.326**	−0.249*	−0.0819	−0.00475	−0.321**	−0.245*	−0.0808
	(0.148)	(0.137)	(0.0975)	(0.103)	(0.148)	(0.137)	(0.0977)
toilet	−0.0637	0.126	−0.113	−0.131	−0.0624	0.125	−0.114
	(0.174)	(0.112)	(0.114)	(0.108)	(0.174)	(0.112)	(0.114)
event_strat2012	−0.0593*	−0.0238***	−0.0101**	−0.0105**			
	(0.0342)	(0.00661)	(0.00493)	(0.00416)			
months_BF	0.00396*	0.00185	−0.00257	−0.00218	0.00390*	0.00183	−0.00258
	(0.00204)	(0.00146)	(0.00181)	(0.00168)	(0.00203)	(0.00147)	(0.00181)
mom_edu	−0.213**	−0.125	−0.170**	−0.191**	−0.216**	−0.125	−0.171**
	(0.102)	(0.0852)	(0.0823)	(0.0834)	(0.101)	(0.0852)	(0.0821)
age	0.0412**	−0.0349***	0.115***	0.0767***	0.0417**	−0.0347***	0.115***
	(0.0185)	(0.0131)	(0.0131)	(0.0112)	(0.0185)	(0.0131)	(0.0131)
age2	−0.000454*	0.000219	−0.00126***	−0.000792***	−0.000459*	0.000217	−0.00126***
	(0.000243)	(0.000175)	(0.000176)	(0.000160)	(0.000243)	(0.000175)	(0.000176)
girl	0.0704	0.0169	−0.183***	−0.259***	0.0723	0.0179	−0.183***
	(0.0843)	(0.0792)	(0.0710)	(0.0715)	(0.0840)	(0.0791)	(0.0709)
rural	0.486***	0.251	0.0151	−0.145	0.452**	0.244	0.00674
	(0.187)	(0.169)	(0.116)	(0.113)	(0.183)	(0.167)	(0.118)
wealth_ind_own	−0.136***	−0.0869**	−0.230***	−0.213***	−0.149***	−0.0915***	−0.233***
	(0.0476)	(0.0340)	(0.0335)	(0.0330)	(0.0461)	(0.0338)	(0.0328)
snprovin	0.0136	−0.000350	0.0324***	0.0272***	0.0144	0.000582	0.0325***
	(0.00966)	(0.00825)	(0.00609)	(0.00581)	(0.00975)	(0.00834)	(0.00613)
nets	−0.366***				−0.362***		
	(0.100)				(0.100)		
iron_supl		−0.00167				0.00235	
		(0.0622)				(0.0632)	
event_civ2012					−0.0701	−0.0332***	−0.0110**
					(0.0459)	(0.00744)	(0.00496)
fatalities2012							
Constant	−2.638***	−0.0612	−2.229***	−1.068***	−2.628***	−0.0701	−2.224***
	(0.346)	(0.262)	(0.258)	(0.209)	(0.346)	(0.261)	(0.259)
Observations	6,486	6,549	7,219	7,219	6,486	6,549	7,219

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

(8)	(9)	(10)	(11)	(12)	(13)	(14)
ciaf_all	malaria	anemia	stunt	ciaf_all	ciaf_all	ciaf_all
−0.00304	−0.324**	−0.248*	−0.0816	−0.00462	−0.00462	−0.00462
(0.103)	(0.148)	(0.137)	(0.0976)	(0.103)	(0.103)	(0.103)
−0.132	−0.0681	0.124	−0.113	−0.131	−0.131	−0.131
(0.108)	(0.175)	(0.111)	(0.113)	(0.107)	(0.107)	(0.107)
−0.00219	0.00415**	0.00202	−0.00250	−0.00210	−0.00210	−0.00210
(0.00167)	(0.00204)	(0.00146)	(0.00181)	(0.00167)	(0.00167)	(0.00167)
−0.191**	−0.203**	−0.119	−0.169**	−0.190**	−0.190**	−0.190**
(0.0832)	(0.101)	(0.0856)	(0.0819)	(0.0832)	(0.0832)	(0.0832)
0.0768***	0.0404**	−0.0357***	0.114***	0.0762***	0.0762***	0.0762***
(0.0112)	(0.0186)	(0.0130)	(0.0131)	(0.0112)	(0.0112)	(0.0112)
−0.000792***	−0.000446*	0.000228	−0.00125***	−0.000786***	−0.000786***	−0.000786***
(0.000160)	(0.000243)	(0.000175)	(0.000176)	(0.000160)	(0.000160)	(0.000160)
−0.258***	0.0673	0.0144	−0.184***	−0.259***	−0.259***	−0.259***
(0.0714)	(0.0840)	(0.0794)	(0.0710)	(0.0714)	(0.0714)	(0.0714)
−0.151	0.451**	0.238	0.00498	−0.156	−0.156	−0.156
(0.114)	(0.186)	(0.168)	(0.117)	(0.115)	(0.115)	(0.115)
−0.215***	−0.146***	−0.0892***	−0.230***	−0.213***	−0.213***	−0.213***
(0.0324)	(0.0447)	(0.0335)	(0.0335)	(0.0329)	(0.0329)	(0.0329)
0.0275***	0.0143	0.000477	0.0325***	0.0273***	0.0273***	0.0273***
(0.00584)	(0.00969)	(0.00839)	(0.00614)	(0.00587)	(0.00587)	(0.00587)
	−0.357***					
	(0.0997)					
		0.000519				
		(0.0643)				
−0.0125***						
(0.00376)						
	−0.0173**	−0.00826**	−0.00310**	−0.00312**	−0.00312**	−0.00312**
	(0.00794)	(0.00324)	(0.00154)	(0.00130)	(0.00130)	(0.00130)
−1.068***	−2.627***	−0.0590	−2.218***	−1.056***	−1.056***	−1.056***
(0.210)	(0.349)	(0.263)	(0.259)	(0.210)	(0.210)	(0.210)
7,219	6,486	6,549	7,219	7,219	7,219	7,219

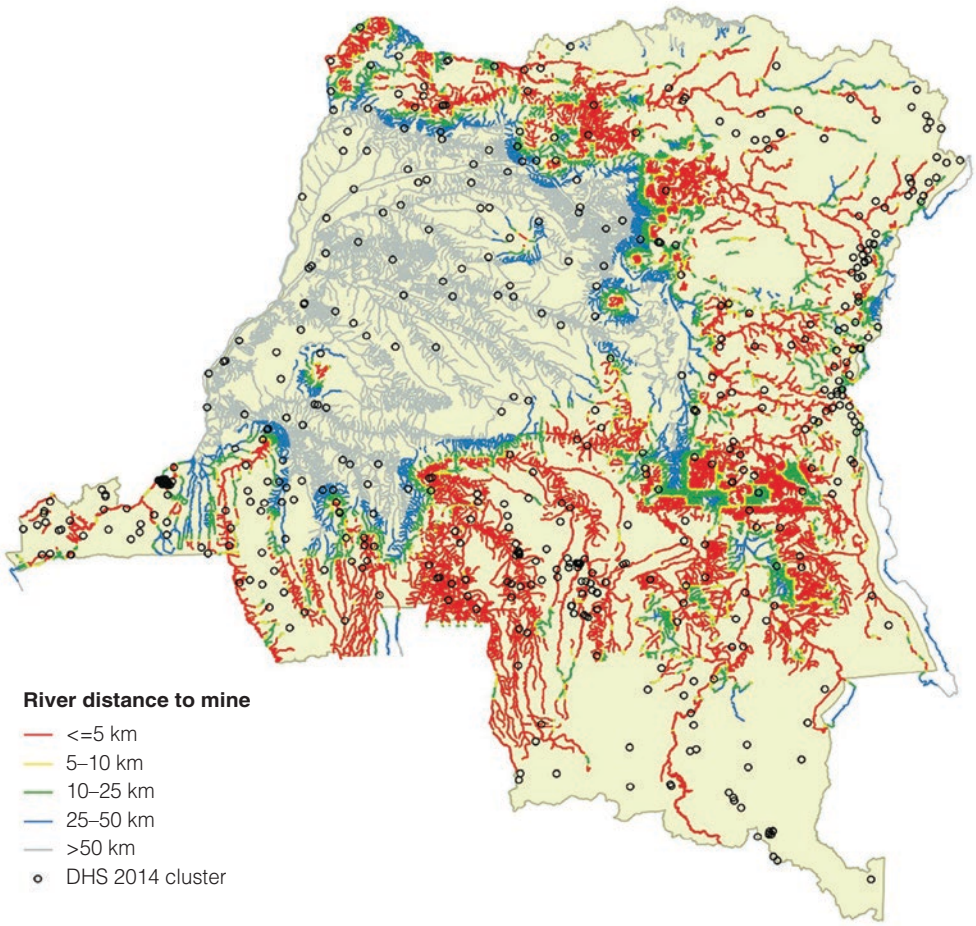
Appendix T
WASH Access, Mining, and Stunting

Table T.1: Regression Results: WASH Access, Mining, and Stunting

	(1)	(2)	(3)
Variables	stunt	stunt	stunt
water	−0.0835	−0.0835	−0.0867
	(0.0987)	(0.0986)	(0.0986)
toilet	−0.0850	−0.0806	−0.0771
	(0.116)	(0.116)	(0.116)
mines5_upstream	0.0120***		
	(0.00313)		
months_BF	−0.00303*	−0.00302*	−0.00300
	(0.00183)	(0.00183)	(0.00184)
mom_edu	−0.181**	−0.182**	−0.179**
	(0.0825)	(0.0826)	(0.0824)
age	0.117***	0.118***	0.117***
	(0.0133)	(0.0134)	(0.0134)
age2	−0.00129***	−0.00129***	−0.00129***
	(0.000179)	(0.000179)	(0.000180)
girl	−0.187***	−0.187***	−0.185***
	(0.0721)	(0.0721)	(0.0718)
rural	−0.0880	−0.0754	−0.0566
	(0.122)	(0.121)	(0.120)
wealth_ind_own	−0.249***	−0.256***	−0.266***
	(0.0326)	(0.0330)	(0.0335)
snprovin	0.0283***	0.0284***	0.0292***
	(0.00625)	(0.00626)	(0.00624)
mines10_upstream		0.00671***	
		(0.00158)	
mines20_upstream			0.00238***
			(0.000572)
Constant	−2.173***	−2.202***	−2.225***
	(0.260)	(0.261)	(0.261)
Observations	7,156	7,156	7,156

Note: Gray shading designates key WASH-related variables. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Map T.1: Major River Systems, by Distance to Mining Permit Location, and DHS-EDS (2014) Survey Clusters



Source: DHS 2014; rivers WRI; mining permits location Ministry of Mines Mining Registry (Cadastre Minier) and Global Forrest Watch.

Appendix U
Stunting and Correlates with WASH and Environmental Context, 2007

Table U.1: Regression Results: Stunting and Correlates with WASH and Environmental Context, 2007

	Children 6–23 months of age		Children 24–59 months of age	
Variables	All	Rural	All	Rural
SPI greater than historic average	−0.100 (0.459)	−0.137 (0.653)	0.039 (0.319)	0.007 (0.437)
SPI less than historic average	0.529 (0.355)	0.440 (0.509)	0.244 (0.225)	0.789** (0.373)
Average monthly Normalized Difference Vegetation Index (NDVI) in prior 12 months	0.726 (2.419)	−1.108 (3.286)	1.928 (1.742)	1.961 (1.644)
VEA between 5 and 10 km	0.205 (0.375)	0.035 (0.526)	0.094 (0.243)	0.209 (0.376)
VEA more than 10 km	0.531** (0.263)	0.416 (0.340)	0.039 (0.208)	−0.027 (0.306)
Fatalities (in '00s)	0.016 (0.028)	−0.121 (0.146)	0.016 (0.010)	0.008 (0.014)
Improved non-shared sanitary facilities	0.153 (0.356)	−0.045 (0.535)	−0.175 (0.221)	−0.190 (0.231)
Percent of cluster households using OD (ln)	0.230** (0.096)	0.209 (0.130)	−0.097 (0.071)	−0.141* (0.085)
Improved water source	−0.183 (0.293)	−0.569 (0.401)	0.167 (0.183)	−0.046 (0.256)
Breastfeeding for care: 0–5 exclusive, 6–23 breastfed	1.080*** (0.393)	0.989* (0.519)		
Immediate skin-to-skin contact, on breast w/in 1 h	0.061 (0.211)	−0.097 (0.262)		

table continues next page

Table U.1: continued

Variables	Children 6–23 months of age		Children 24–59 months of age	
	All	Rural	All	Rural
Child sleeps under a mosquito bed net	–0.426**	–0.602**	–0.540***	–0.655**
	(0.201)	(0.246)	(0.202)	(0.270)
Had four or more prenatal checks	–0.488*	–0.500		
	(0.267)	(0.362)		
Birth assisted by trained professional	0.337	0.065	–0.338	–0.382
	(0.285)	(0.351)	(0.221)	(0.260)
Vaccinations up to date	–0.833***	–0.901**	0.195	0.458
	(0.291)	(0.369)	(0.229)	(0.372)
Child is a girl	–0.169	–0.249	–0.363***	–0.419***
	(0.233)	(0.320)	(0.109)	(0.160)
Age (months)	0.105***	0.106***	0.005	0.007
	(0.023)	(0.030)	(0.006)	(0.008)
2nd in birth order	0.163	0.343	–0.214	–0.038
	(0.378)	(0.498)	(0.233)	(0.312)
3rd or more in birth order	0.656	0.726	0.315	0.424
	(0.464)	(0.572)	(0.222)	(0.309)
Child is twin or multiple	1.303	1.094	1.262*	1.729**
	(0.888)	(1.037)	(0.646)	(0.757)
Child normal or large sized at birth	–0.544	–0.592	–0.080	0.107
	(0.368)	(0.502)	(0.247)	(0.335)
Mother's height (cm)	–0.015	–0.012	–0.041***	–0.031*
	(0.016)	(0.023)	(0.013)	(0.016)
Mother's BMI	0.003	0.034	–0.063***	–0.075*
	(0.036)	(0.064)	(0.023)	(0.038)
Age at first pregnancy	0.048	0.038	–0.011	–0.034
	(0.041)	(0.049)	(0.025)	(0.032)
Total number of live births	–0.041	–0.133	–0.039	–0.073
	(0.080)	(0.101)	(0.041)	(0.057)
Number of years of education of mother	–0.003	0.038	–0.066**	–0.085**
	(0.033)	(0.037)	(0.028)	(0.043)
Wealth index created by us	0.150	0.822***	–0.143*	0.159
	(0.105)	(0.262)	(0.074)	(0.226)
Constant	–2.504	–0.205	6.646***	5.704*
	(3.281)	(4.489)	(2.471)	(3.108)
Observations	847	491	1,648	959

Note: Gray shading designates key WASH-related variables. Includes province-level fixed effects. Variables of similar type are grouped in shaded rows. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

Appendix V
Multi-Sectoral Nutrition Framework (Synergy Analysis)

The multi-sectoral nutritional analysis (synergy analysis) was undertaken by Katja Vinha (Consultant, World Bank). A full report of this analysis is available upon request and part of the final package of the Democratic Republic of Congo WPD.

Background and Econometric Model

Malnutrition is prevalent in Democratic Republic of Congo. In 2013, 29 percent of children 0–23 months of age were stunted, with higher prevalence rates in the rural than urban areas, 32 and 21 percent, respectively. Children from households in the bottom 20 percent of the wealth distribution were more likely to be stunted than children from households in the top 20 percent of the distribution, 33 and 15 percent, respectively. Since stunting, a measure of malnutrition, is associated with impaired cognitive function, lower economic productivity, and adverse health outcomes for self and, if female, for offspring (Victora et al. 2008), understanding the interplay of factors associated with stunting is of paramount interest. Furthermore, to efficiently focus efforts, it is necessary to identify the factors that in a given context are most effective in improving child nutrition.

In 1990, UNICEF proposed a framework that presented nutrition as a function of three underlying determinants of food security, environment, and health, and childcare practices. Skoufias et al. (2015) have used an extension of the framework to analyze the correlation across different countries and the same methodology is used for Democratic Republic of Congo. The methodology allows for the identification of current data limitations, systematically explores the correlates and determinants of nutrition, identifies potentially "binding constraints" in reducing malnutrition and identifies potential interactions and synergies among different dimensions

It is important to question whether or not some dimensions contribute more to nutrition than others and whether or not there are synergies among the dimensions. That is, it may be that having access to two of the four dimensions incurs additional benefit beyond any benefits from access to the dimensions in isolation. However, the extant empirical evidence for Democratic Republic of Congo provides a very partial picture regarding a young child's nutritional status and adequate access to food security, environment, health, and child care.

From a policy perspective, it is useful to have an understanding of which dimensions are correlated with better nutrition in specific contexts. Furthermore, if there are any synergies from access to a subset of the four dimensions, such relationships should be included in any potential benefits. The correlations are not only undertaken in the national context but also in urban–rural areas separately, as well as for children in the bottom 40 percent of the household wealth distribution and those in the top 60 percent of the household wealth distribution.

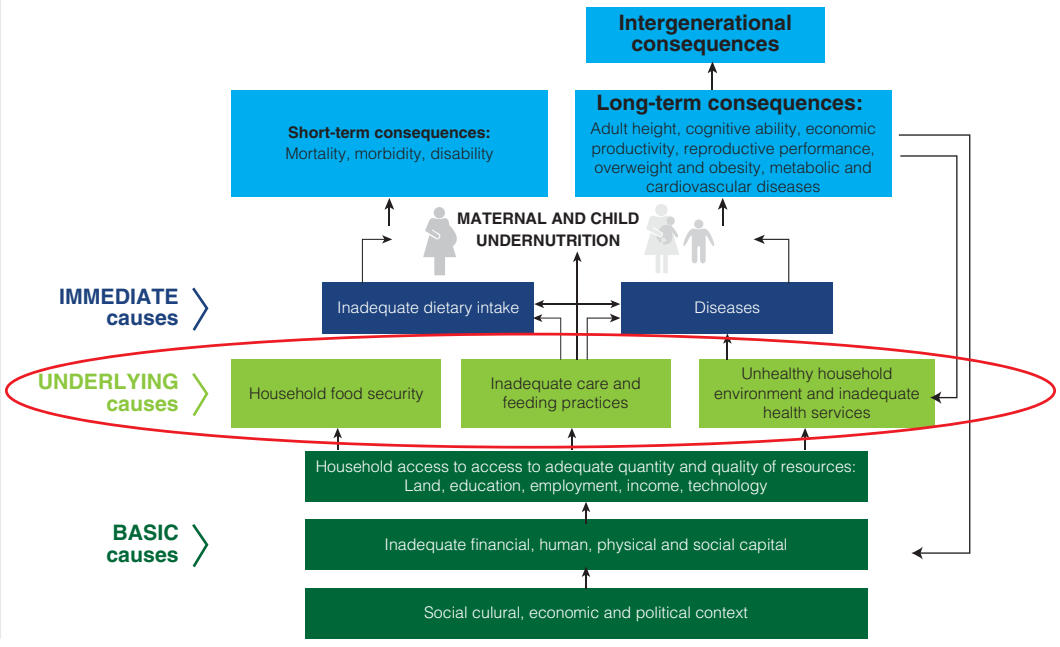
The specific questions asked are:

- Which nutritional dimensions is Democratic Republic of Congo most lacking and which specific components are least likely to be achieved?
- Are there differences in access to nutritional dimensions that vary across different subpopulations?
- Which set of nutritional dimensions are positively correlated with nutrition in different subpopulations?
- Are there synergies from having access to more than one dimension?

Multi-Sectoral Nutrition Framework

The multi-sectoral nutrition framework classifies the causes of malnutrition into three hierarchical categories: the immediate causes, the underlying causes, and the basic causes. Identifying the immediate causes of malnutrition, that is disease or inadequate dietary intake, is useful for guiding policy actions, especially in situations of crisis. However, disease and inadequate dietary intake are the result of a variety of interrelated underlying factors. In the original framework, the underlying causes of malnutrition are themselves grouped into the three clusters: inadequate household food security; inadequate care and feeding practices; unhealthy household environment and inadequate health services. In figure V.1, the original model is extended and considers access to a healthy environment and to adequate health services separately. This is especially useful given that in many contexts different agencies have jurisdiction over infrastructure, such as sanitation and drinking water, and over health. Below, the underlying causes are the basic causes which summarize the social, cultural, economic, and political context, and the prevailing inequalities in the distribution of resources in society.

Figure V.1: Conceptual Framework of the Causes of Undernutrition and Its Linkages to WASH



Source: Adapted from (Skoufias, 2016)

Given that the underlying causes are the manifestation of the basic causes, they are prioritized in the analysis. However, any policy to improve nutritional outcomes would, in fact, need to address any inequalities or shortcomings in the basic causes.

The first dimension of nutrition is access to adequate food security. A child is food secure when at all times, they have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Food and Agriculture Organization, 2008). The ideal measure encompasses three broad factors. First, a comprehensive measure takes into account the availability of food. In general, this component measures the supply of food at the national (or regional) level and is based on agricultural production and food trade balance relative to the country's size. Second, the measure captures the household-specific and individually specific access to the available food. That is, given household's income and the prices of food at local markets, what range of food choices are available to the household, and, within the household, how is the food distributed. Third, the measure captures the quality of the actual food choices made by the household. That is, it measures whether or not the diet and cooking methods provide all the necessary micro- and macronutrients needed for healthy growth.

The second dimension of nutrition is access to adequate care. This dimension measures the ability of the primary caregiver to provide a safe and appropriate environment for the child to grow and develop. Ideally, the measure is based on the child's caregivers' (i) knowledge, practices, and beliefs regarding childcare; (ii) health and nutritional status; (iii) mental health, stress level, and self-confidence; (iv) autonomy and control of resources; (v) workload and time constraints; (vi) social support received from family and community.

The third dimension is access to adequate environment (WASH). The dimension measures the child's exposure to pathogens in the physical environment where they live. The measure is based on adjusted definitions adopted by the WHO/UNICEF Joint Monitoring Program (JMP) and as part of monitoring the SDGs. It includes components on: (i) access to improved drinking water; (ii) access to improved sanitation; (iii) adequate handwashing practices; and (iv) adequate disposal of child's feces. Given that it is not only the child's immediate environment, i.e. the facilities in the dwelling unit, but also those in the immediate neighborhood that affect the degree of exposure to pathogens, communitywide access to improved sanitation is explored.

The fourth dimension is access to adequate healthcare. This dimension measures the child's access to skilled medical care to minimize the effects of illness and prevent health issues, especially those linked with malnutrition, such as diarrheal diseases. The measure encompasses the availability and use of healthcare services for prenatal, birth, and post-natal care.

Contexts matter, such that the effect of lack of access to a specific dimension in one context may be quite different than in another context. For example, although access to potable water is important for all children, but for those 0–6 months of age who are exclusively breastfed and thus not directly consuming any water, such access may not be as important (or even necessary) from a purely nutritional standpoint. Alternatively, the interaction of the nutrition dimensions may look quite different in rural areas than in urban areas.

Although the framework is a holistic way of conceptualizing nutrition it is also important to acknowledge the limitations of the classification scheme. Prices, knowledge, education, and household income all influence components of the three clusters of the framework, resulting in some overlap in the measures. The methodology is informative in finding the overall relationships, from which more focused and detailed analyses can be carried out to further investigate the underlying causes. So, for example, more detailed information would be needed to determine whether food inadequacies were due to the cost of food relative to income, to lack of information on the importance of diversified diet, or due to some other factor. The models estimated in this report are not reduced form models (taking into account budget constraints, etc.) as in Barrera (1990), but rather correlations between

nutritional outcomes as measured by height-for-age *Z*-scores and having adequate access to the four dimensions on nutrition.

Econometric Model

To explore the relative importance of the nutrition dimensions and any potential synergies among the four underlying determinants and nutritional outcomes, a simple regression model is used to summarize the differences in the mean height-for-age among children with access to only one or more of the four nutritional dimensions. The analysis is purely descriptive, quantifying the correlation between height-for-age *Z*-scores and simultaneous access to adequate levels in more than one of the nutrition dimensions. The following description is based on Skoufias et al. (2015) with the modification that access to adequate environment is considered separately from access to adequate health care.

The following econometric specification is estimated:

$$HAZ_i = \alpha + \sum_{j=1}^{4} \beta_j A_j + \sum_{j=1}^{4} \sum_{k=j+1}^{4} \gamma_{jk}(A_j * A_k) + \sum_{j=1}^{4} \sum_{k=j+1}^{4} \sum_{m=j+2}^{4} \gamma_{jkm}(A_j * A_k * A_m) + \gamma_{1234}(A_1 * A_2 * A_3 * A_4) + \varepsilon_i \quad \text{(V.1)}$$

where HAZ_i is the height-for-age *Z*-score for child *i,* and A_i denotes access to the four adequacies, for each child *i*. Namely, A_1 is 1 when the household is adequate in food and is 0 otherwise; A_2 is 1 when the household is adequate in environment and is 0 otherwise; A_3 is 1 when the household is adequate in health and is 0 otherwise; and, A_4 is 1 when the household is adequate in care and is 0 otherwise. These binary variables are constructed without any consideration of whether the child has access to adequate levels in the other three clusters. It is also important to keep in mind that there are no additional control variables used in the regression because the objective here is simply to compare mean values in HAZ among children in these different sub-groups defined by the extent to which they have access to one or more of the pillars.

In this specification, the constant term α provides an estimate of the mean value of HAZ scores for children without access to adequate food security ($\boldsymbol{A}_1$= 0), adequate environment ($\boldsymbol{A}_2$= 0), adequate health ($\boldsymbol{A}_3$= 0), and adequate care ($\boldsymbol{A}_4$= 0). That is, the expected height-for-age for a child without access to any of the four dimensions is:[1]

$$E(HAZ_i | A_1 = 0, A_2 = 0, A_3 = 0, A_4 = 0) = \alpha$$

The coefficients β_j yield estimates of the increase in the mean HAZ score of children when a child has access to adequate levels in one of the dimensions only (and not the others). That is:

$$\begin{aligned} E(HAZ_i | A_1 = 1, A_2 = 0, A_3 = 0, A_4 = 0) &= \alpha + \beta_1 \\ E(HAZ_i | A_1 = 0, A_2 = 1, A_3 = 0, A_4 = 0) &= \alpha + \beta_2 \\ E(HAZ_i | A_1 = 0, A_2 = 0, A_3 = 1, A_4 = 0) &= \alpha + \beta_3 \\ E(HAZ_i | A_1 = 0, A_2 = 0, A_3 = 0, A_4 = 1) &= \alpha + \beta_4 \end{aligned} \quad \text{(V.2)}$$

Specifically, the coefficient β_1 yields an estimate of the increase in the mean HAZ score of children who have access to adequate food security only (A_1=1) but do not have access to adequate environment, (A_2=0), adequate health (A_3=0) or adequate care (A_4=0). The coefficients β_2,β_3, and β_4 have analogous interpretations for environment, health, and care, respectively.

The coefficients γ_{jk} yield estimates of the synergies or complementarities associated with having access to adequate levels in more than one of the cluster of underlying determinants of nutrition. Specifically, the mean HAZ score of children having access to adequate food security (A_1= 1) *and* adequate environment (A_2= 1) is summarized by the expression:

$$E(HAZ_i | A_1 = 1, A_2 = 1, A_3 = 0, A_4 = 0) = \alpha + \beta_1 + \beta_2 + \gamma_{12} \quad \text{(V.3)}$$

The expression for the mean value of HAZ scores of children in households with access to adequate food security *and* adequate environment consists of the sum of three components: the first component is the increase in HAZ scores associated with children in households with adequate food security only (i.e. β_1); the second component (β_2) is the increase in HAZ scores associated with children in households with adequate environment only, and the third component (γ_{12}) is the increase in HAZ scores associated with children in households that have access to both adequate food security *and* adequate environment. Thus the coefficient γ_{12} yields information on whether there are additional (extra) gains (or losses) in HAZ scores derived from simultaneous access. A significant and positive value of the coefficient γ_{12} implies synergies from the simultaneous access to adequate food security and adequate environment in the production of child nutrition. The mean HAZ of children from having access to the other two adequacies (for example, food and care, or environment and care, etc.) are similarly defined.

The mean HAZ of children from having access to three components (i.e. adequate food security (A_{i1}=1) *and* adequate environment (A_{i2}=1) *and* adequate health (A_{i3}=1)) is given by the expression:

$$(HAZ_i | A_1 = 1, A_2 = 1, A_3 = 1, A_4 = 0) = \alpha + \beta_1 + \beta_2 + \beta_3 + \gamma_{12} + \gamma_{13} + \gamma_{23} + \gamma_{123} \quad \text{(V.4)}$$

with the coefficient γ_{123} summarizing the potential synergies from simultaneous access to the three components. These are synergies in addition to any synergies from pairwise interactions.

And similarly the mean HAZ of children from having access to all four components is given by the expression:

$$(HAZ_i | A_1 = 1, A_2 = 1, A_3 = 1, A_4 = 1) = \alpha + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \gamma_{12} + \gamma_{13} + \gamma_{14} + \gamma_{23} + \gamma_{24} + \gamma_{34} + \gamma_{123} + \gamma_{124} + \gamma_{134} + \gamma_{234} + \gamma_{1234}. \quad \text{(V.5)}$$

In the above model, in order to estimate the synergies, the indicator variables are non-exclusive, such that a child adequate in more than one nutritional dimension will have more than one indicator variable equaling one. In order to compare the average heights of a child with certain adequacies and a child with no adequacies, all relevant coefficients must be summed up. That is, the γ_j's values do not reflect the height differential between those with the adequacy set *j* with respect to children without access to any of the nutritional dimensions.

Alternatively, it is possible to assign each child to exclusive groupings such that each child has only one indicator variable, B_j, equaling one. In this formulation, the coefficient estimates, λ_j, reflect these total height differentials between a child with a given set of adequacies and a child with none. Thus, the equation to be estimated can be written as

$$HAZ_i = \alpha + \lambda_1 B_1 + \lambda_2 B_2 + \lambda_3 B_3 + \lambda_4 B_4 + \lambda_{12} B_{12} + \lambda_{13} B_{13} + \lambda_{14} B_{14} + \lambda_{23} B_{23} + \lambda_{24} B_{24} + \lambda_{34} B_{34} + \lambda_{123} B_{123} + \lambda_{124} B_{124} + \lambda_{134} B_{134} + \lambda_{234} B_{234} + \lambda_{1234} B_{1234} \quad \text{(V.6)}$$

where only one B_j will be equal to one and the rest will be equal to zero. So, a child adequate in food security but nothing else will have B_1 = 1 and B_j = 0$\forall j \neq 1$, and a child adequate in food security and environment will have B_{12} = 1 and B_j = 0$\forall j \neq 12$ That is, the values of λ_j give the height differential for children with the adequacy set associated with *j* with respect to those who are not adequate in any dimension. When the adequacy groupings are completely specified the coefficient estimates from (V.1) can be rearranged to give the coefficient estimates in (V.6).[2]

Table V.1: Definitions Used in Total Effects and Synergy Models

Adequacy	Components used (age group applicable)	Definition 1	2	3	4
Food	Exclusive breast feeding (0–5 month olds)	✓	✓	✓	✓
	Dietary diversity (6–23 month olds)	✓	✓	✓	✓
	Feeding frequency (6–23 month olds)	✓	✓	✓	✓
Care	Immediate breastfeeding after birth (all)	✓	✓	✓	✓
	Appropriate breastfeeding (0–23 month olds)	✓	✓	✓	✓
	Complementary feedings (6– 8 month olds)	✓	✓	✓	✓
	Use of mosquito bed nets (all)		✓	✓	✓
	Mother literate				
	Mother empowered				
	Mother has access to media				
Health	At least four prenatal checkups (all)	✓	✓	✓	✓
	Birth assisted by a skilled professional (all)	✓	✓	✓	✓(mod)
	Post-natal checkup (all)			✓	
	Immunizations up to date (all)	✓	✓	✓	✓
	Vitamin A supplementation (9–35 month olds)			✓	
Environment	Access to improved sanitation (all)	✓	✓	✓	✓
	75 percent of community with improved sanitation (all)				
	Access to basic drinking water (all)	✓	✓	✓	✓

Table V.2: Distribution of Children in Adequacy Groupings, 2013

Adequate only in…	National Defn 1	**Defn 2**	Defn 3	Defn 4	Rural Defn 2	Urban Defn 2
None	31%	**41%**	49%	45%	44%	32%
Food	4%	**8%**	10%	8%	8%	6%
Care	27%	**18%**	21%	19%	21%	10%
Environment	3%	**3%**	5%	4%	2%	6%
Health	9%	**11%**	2%	6%	8%	18%
Food and care	9%	**5%**	7%	6%	5%	4%
Food and environment	0%	**0%**	1%	1%	0%	0%
Food and health	2%	**3%**	0%	2%	2%	4%
Care and environment	2%	**2%**	2%	2%	1%	3%
Care and health	7%	**4%**	1%	3%	3%	7%
Environment and health	1%	**2%**	0%	1%	1%	3%

table continues next page

Table V.2: continued

	National				Rural	Urban
Adequate only in…	Defn 1	**Defn 2**	Defn 3	Defn 4	Defn 2	
Food, care, and environment	1%	**0%**	1%	0%	0%	0%
Food, care, and health	3%	**2%**	0%	1%	2%	3%
Care, environment, and health	1%	**1%**	0%	0%	1%	1%
Food, environment, and health	1%	**1%**	0%	1%	0%	2%
In all four	0%	**0%**	0%	0%	0%	1%
Total	100%	**100%**	100%	100%	100%	100%

Source: DHS 2013–14.

Table V.3: Percentage of Children Adequate in Various Categories (Poor vs. Non-Poor)

	Defn 2	
Adequate only in….	Poor	Non-poor
None	36%	27%
Food	4%	4%
Care	35%	21%
Environment	1%	4%
Health	5%	12%
Food and care	8%	9%
Food and environment	0%	0%
Food and health	1%	2%
Care and environment	2%	3%
Care and health	3%	9%
Environment and health	0%	2%
Food, care, and environment	0%	1%
Food, care, and health	3%	3%
Care, environment, and health	1%	1%
Food, environment, and health	0%	1%
In all four	0%	1%
Total	100%	100%

Source: DHS 2013–14.

The model employed does not allow for causal inferences on the effects of having access to adequate levels in the various clusters adequacy components on nutrition nor provide a formal test of the UNICEF framework. A more rigorous causal analysis would require the use of methods aimed at addressing the endogeneity bias associated with the fact that many of the dimensions are to a large extent choice variables (e.g., a parent chooses to care for their child in a certain way or take the child to see a health care professional) as well as the inclusion of additional control variables aimed at reducing or eliminating the impact of other contextual variable omitted from the regression (omitted variable bias).

Nevertheless, the estimates from the model serve as a useful benchmark for policy in terms of highlighting the potential gains that could be accomplished with having simultaneous access to adequate levels of various dimensions. This specification allows for the exploration of the

patterns of correlation between the various adequacy measures and nutritional outcomes as measured by height-for-age. That is, the model estimates the correlation between adequacies and height-for-age for each set of adequacies based on information in one time period.

Notes

1. It is also assumed that $E(\varepsilon_i | A_1, A_2, A_3, A_4) = 0$.
2. If the non-exclusive model is not fully specified and some interaction terms are grouped together, such as instead of including all four 3-way interaction terms γ_{jkm}a, including an indicator variable indicating whether or not the child is adequate in any three nutritional dimensions, then the correspondence no longer holds.

References

Food and Agriculture Organization. (2008). http://www.fao.org/docrep/013/al936e/al936e00.pdf. Rome, Italy. Retrieved 5 10, 2017, from http://www.fao.org/docrep/013/al936e/al936e00.pdf

Skoufias, E. (2016). *Synergies in Child Nutrition: Interactions of Food Security, Health and Environment*. Washington DC: World Bank.

Appendix W
Notes on WASH Variables Processing Across Surveys

The Adjustment to Improved Sanitation

DHS-EDS 2014, DHS 2007, and LSMS 2012 are used to calculate the adjustment factor for improved sanitation based on the average percentage shared of otherwise improved sanitation in urban and rural across these years. This is how the JMP makes this adjustment and this approach was followed in the present analysis.

This ratio is then applied to urban and rural households, respectively, with improved sanitation (shared and unshared), to obtain the main variable to measure improved sanitation (named SanJMP2_imp). The same ratio is applied across all years included in the sanitation analysis (DHS-EDS 2014, DHS 2007, and LSMS 2012, LSMS 2005, and MICS 2001). The reasons that LSMS 2005 and MICS 2001 are not included in the calculation of the ratio is that for LSMS 2005, there is some ambiguity in the pit latrine improved/not-improved category, so an estimate of improved sanitation is taken by counting pit latrines as unimproved in order to get a conservative estimate, but we do not want it to affect the adjustment factor. For MICS 2001, no question of shared or not was asked; the 2010 MICS is not used for any main sanitation calculations because of ambiguity.

Two separate variables that show the true (i.e. reported for that year) improved, not shared [SanJMP4_imp]; improved, shared status of the household [SanJMP4_shared] have been generated. Note that for 2001, SanJMP4_imp represents all improved and SanJMP4_shared is missing because this question was not asked.

In the main calculations of time series and poverty by improved, SanJMP2_imp is used (labeled “adjusted” in the graphs). However, the Human Opportunity Index (HOI) and logit calculations use SanJMP4_imp as the improved variable in order to have a binary improved, not-improved variable (i.e. shared is considered unimproved here). Similarly, the access plus numbers use SanJMP4_imp to show the actual improved/not shared sanitation per year (leaving 2001 blank in addition to 2010).

Differences from JMP

The Joint Monitoring Program (JMP) uses regression to *estimate* the improved shared per year while the research team choose to calculate it using the numbers for each year, with the only cross-year imputation exception being the adjustment for sanitation.

Differences from Global Team

The research team proceeded to calculate sanitation figures with the LSMS 2005, in spite of the potential for ambiguity identified for improved/unimproved sanitation as a conservative estimate of improved shared (by fully counting the ambiguous pit category as unimproved).

Urban

Note that *all* calculations that are labeled with "urban"; "other urban" are urban areas outside of Kinshasa.

Shares

Shares are *always* population shares (never household shares). For example, the rate of improved access to water (percent) for female-headed households in the first decile is the population rate living in these households.

Weights

Calculations use the weights provided (household weight × household size) in MICs and DHS. For LSMS, the weights used are those provided by the Poverty Economist for the Democratic Republic of Congo. These weights have been corrected to be in line with the UN population projections.

Concern About Large Fluctuations in Improved Sanitation for Certain Areas (South Kivu and Maniema)

South Kivu and Maniema show very large changes between 2001 and 2014 in improved sanitation. See figure W.1 that examines these provinces in comparison to others.

Figure W.1: Share of Population with Access to Different Sanitation Technologies (by Former Provinces)

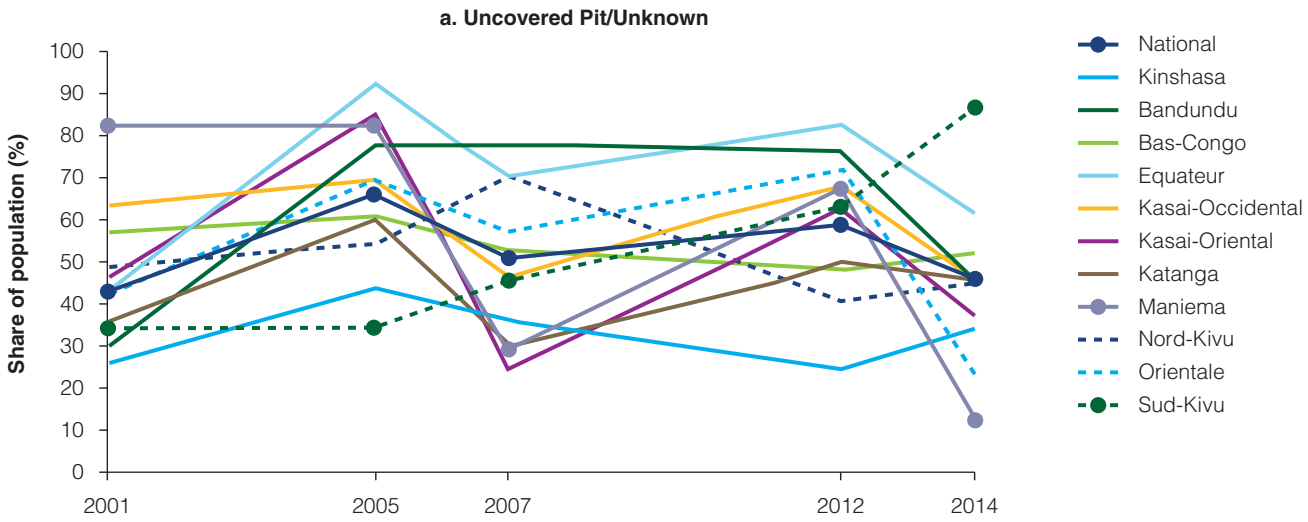
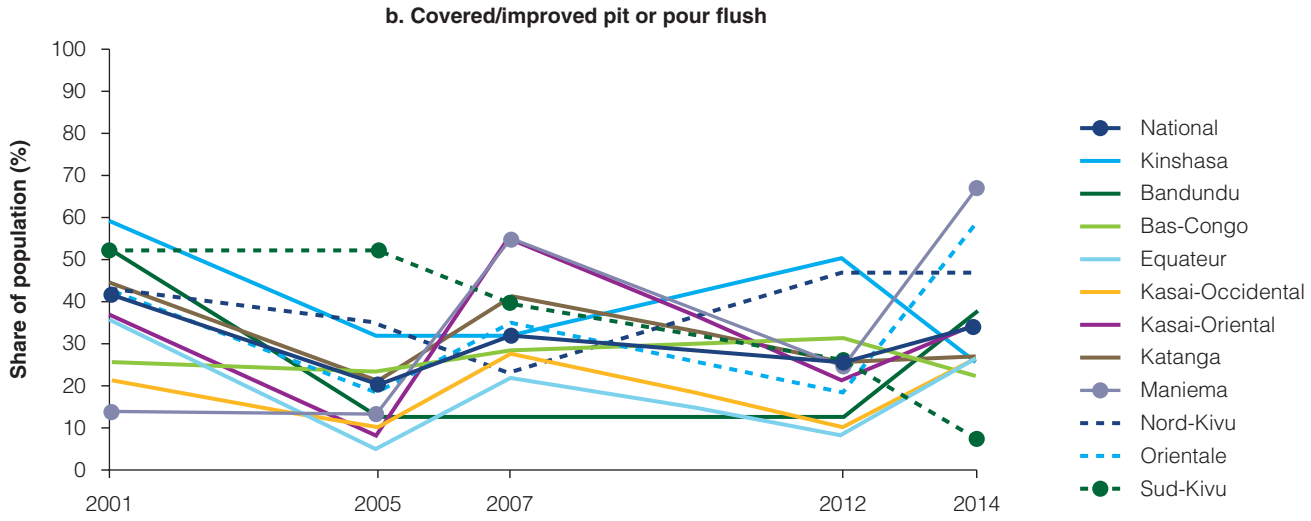


Figure W.1: continued



Source: World Bank calculations using MICS 2001: LSMS 2006, 2012: DHS 2007, 2014.
Note: Improved sanitation is all reported not shared in the reference year 2001 does not include a question for shared, so all improved are considered improved.

Theory: different surveys are either defining or interpreting covered toilets differently (i.e. the same type of toilets are being recorded as both covered or uncovered, depending on the survey). Specifically, in MICS/DHS 2001, 2007, and 2014 uncovered is low/covered high; in LSMS 2005 and 2012 uncovered is high/covered is low. This is likely due to the lower bounds we are observing for LSMS.

The fluctuation for Maniema follows this trend and may just have a more pronounced fluctuation than others as most change from year to year but the national average lessens this difference.

However, the strange fluctuation in South Kivu is against trend and is a steady increase in unimproved. There may be something about these pit toilets that make it harder to classify than others (e.g., they are sometimes covered and sometimes not), but this is something that the team going into the field should specifically verify.

Large Difference between Expenditure/Poverty Numbers and Wealth Index

The poverty files provided by the Poverty Economist for the Democratic Republic of Congo only have expenditure already adjusted for spatial differences and poverty is also calculated based on these spatially adjusted expenditures. Meanwhile, the wealth index that DHS includes does not adjust for spatial differences. This likely explains the big differences between the urban/rural shares of the B40 when using one versus the other (along with other factors such as the wealth index being designed more with urban in mind than rural).

Appendix X Overview of Poverty Risk Model (PRM)

The PRM analysis and report was prepared by the University of Florida (UF) and the London School of Hygiene and Tropical Medicine (LSHTM) for the World Bank and led by Rick Rheingans (UF) and Oliver Cumming (LSHTM). This work is part of the WASH Poverty Diagnostic project led by Oxford Policy Management (Rheingans et al. 2016). The full report including references is available upon request.

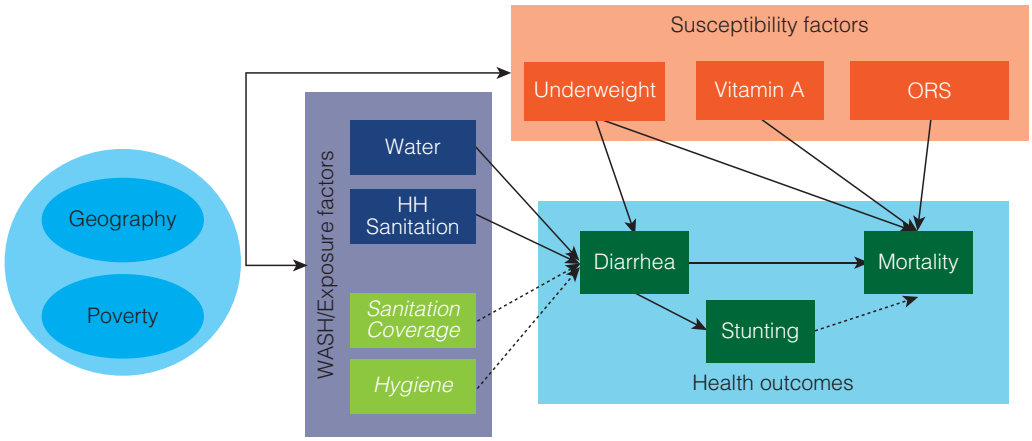
The primary purpose of this model is to describe how diverse and interrelated risk factors may contribute to how the national diarrheal disease burden is distributed between subpopulation groups (e.g., between wealth quintiles). We do not estimate the association or causality between WASH and these outcomes as the data is cross-sectional and prone to many biases. These descriptions are both quantitative (by economic group and setting) and spatial (through a series of heat maps showing intensity of risk) in nature. An understanding of the co-distribution of these risk factors will be used to identify the most consequential factors or combination of factors that require intervention.

The core PRM model combines key "susceptibility factors" and "exposure factors" that are most relevant to the health outcome of interest: diarrhea. The relative risks (defined below; see methods) associated with these exposure and susceptibility factors are derived from published systematic review based meta-analyses as per conventional practice (Murray and Lopez 1997). The relative risks are not estimated in each setting due to insufficient context-specific literature for the various model parameters, but national-level data is used to inform the model. This approach is consistent with conventional burden of disease analyses.

It is worth noting that the concept of a "relative risk" is a common and established approach in the epidemiological literature (Hennekens and Buring 1989; Levin 1953). It represents the level of disease risk among "exposed" individuals, those with a particular risk factor (e.g., *not* having safe drinking water) compared to "unexposed" individuals, those without that risk factor (e.g., *having* safe drinking water). A relative risk greater than 1.0 therefore shows a greater risk of a given disease among the exposed versus the unexposed and a relative risk of less than 1.0 by contrast shows that the risk factor among the exposed is protective against the disease. Relative risk estimates are derived from pooling the effect sizes of high-quality studies designed to assess the effect of a given factor on a given disease, such as the effect of safe drinking water on diarrheal disease. These studies should be identified using systematic review methods (Higgins and Green 2008) that limit investigator bias and the pooled effect—an average effect from across included studies—should be calculated using conventional and reproducible methods (Higgins and Green 2008) and the methods and results should be reported as per conventional best practice (Moher et al. 2015).

The conceptual framework for the WASH-PRM is explained in figure X.1. The "Exposure Factors" section of the figure includes WASH-related elements that influence the risk of diarrheal disease. Relative risks are developed from the literature for different levels of these WASH services. Relative risks for individual exposure risk factors are combined into a single "exposure index".

Figure X.1: WASH Poverty Risk Model Conceptual Framework



Note: WASH/Exposure Factors in light green are not included in the Exposure Index.

The "Susceptibility Factors" section of the conceptual framework addresses individual risk factors that have been identified through rigorous evaluations and meta-analyses. Quantitative risk estimates for each factor are combined into a single "susceptibility index". We also include explorations of other potentially important exposure factors (shown in light green in figure X.1; described in Table 3 in Section 2) that are not included in the core model in this report (listed in Section 0). They are not included in the base model due to inconclusive evidence of the magnitude of excess risk or lack of data on conditions and behaviors.

The model further assumes that patterns of susceptibility and exposure patterns differ within and between countries based on geography and economic conditions. The patterns and correlations between these risk factors are assessed through household survey data in each context. Overall, the WASH-PRM assesses patterns of disease risk across economic and geographic subpopulations by combining rigorous estimates of the effects of exposure and susceptibility factors with country-specific data on the distribution of these risk factors.

Methods

Defining Exposure Risk Factors

As described in the conceptual diagram (figure X.1), we consider water and sanitation as "exposure" factors, that is, as independent variables that influence our dependent outcomes of interest (diarrheal disease, diarrheal mortality, and stunting).

Under the MDG target for water and sanitation, access to these two services was classified as "improved" or "unimproved", with progress on improved services contributing to progress in meeting the MDG target. This binary classification of water and sanitation into masks a gradient of ascending service levels that bring differing levels of health and other benefits. More recently, the WASH sector has moved to a 'service ladder' approach that better describes water and sanitation access as a continuum of ascending levels assumed to bring ascending benefits. The new SDG to "ensure access to water and sanitation for all" by 2030 goes beyond unimproved/improved to call for safely managed water and sanitation services.

In understanding the risk posed by inadequate water and sanitation access to different groups, it is important to consider multiple service level or "exposure" scenarios which distinguish between, for example, improved sanitation and a sewer connection, and allow for different

Box X.1: Relative Risk and the WASH Risk Index

What does "Relative Risk" mean?

Relative Risk (RR) is a concept commonly used in public health and epidemiology to quantify how a particular risk factor (for example, having an improved water source) may increase or decrease the risk of a specific health outcome, compared to a baseline. An RR of less than 1 means a factor is protective in comparison to not having it. An RR greater than 1 means that it results in an increase in risk.

We use RR information on various factors related to childhood health and diarrhea, some of which increase risk, while others decrease it. The quantitative estimates of RR are drawn from rigorous studies designed to assess causal effects within the published literature.

Developing a WASH Risk Index

A key part of the WASH-PRM is the development of a WASH Risk Index. This index is based on the conceptual model in figure X.1. The index combines quantitative information on household WASH and health to quantify the relative risk of adverse child health outcomes due to inadequate WASH.

How is it calculated?

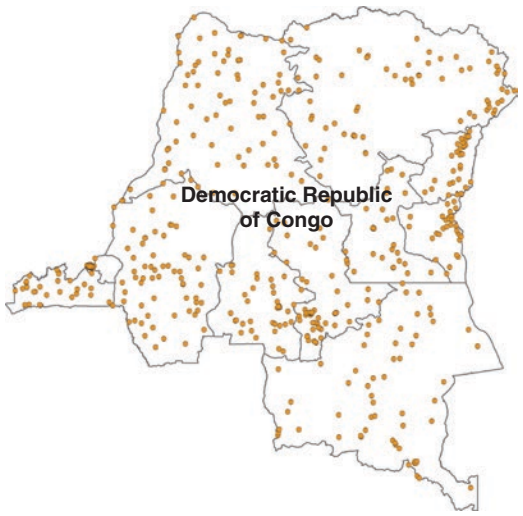
The index is calculated at the level of the child. The index combines information on the child's household WASH characteristics, individual health vulnerabilities, and the relative risk associated with each factor. The RRs for each factor are multiplied together to develop a cumulative risk index. Some risk factors (for example, improved water, access to vitamin A) decrease risk. Others (for example, underweight) increase risk. It is important to note that the weight of each factor is neither equal nor arbitrary. The weight of each is based on what the evidence in the literature provides as a relative risk.

The relative risk scores are combined into an Exposure Index (WASH variables) and a Susceptibility Index (health-related factors), and these two indices comprise the combined Risk Index.

relative risks of a given health outcome for each exposure level. Many systematic reviews pool different water, sanitation, and hygiene interventions to arrive at a single relative risk estimate for all interventions within a given category (water, sanitation, and hygiene) against a single counter-factual of "no intervention," often failing to account for differences in service level and the control.

Two previous efforts to assign relative risks (RR) to various WASH exposure scenarios applied literature-based estimates to an ascending level of single and then multiple WASH services, but only distinguished between one or two levels of water and sanitation service (Cairncross and Valdmanis 2006; Prüss et al. 2002). For the WASH-PRM, we will adopt the exposure scenarios and accompanying RR estimates proposed in a recent WHO-led burden of disease analysis. These RRs are determined using a meta-analysis based on a systematic review of

Map X.1: Map of 2013–14 DHS Clusters in Democratic Republic of Congo



Source: DHS-EDS 2014.

Table X.1: Exposure Risk Model Parameters

Input	Value	Description	Reference
Water access relative risk		**2013–2014 DHS Household File**	**2013–2014 DHS Congo, Dem. Rep.**
A. Unimproved	1.00	"Dug well: Unprotected Well", "Water from Spring: Unprotected Spring", "Tanker Truck", "Cart with Small Tank", "Surface Water (River/Dam/Lake/Pond/Stream/Canal/ Irrigation Channel)", "Bottled Water"	HV201
B. Off-plot improved	0.89	"Piped Water to Neighbor", "Public Tap/ Standpipe", "Tube Well or Borehole", "Dug Well: Protected Well", "Water from Spring: Protected Spring" and "Rainwater"	HV201
C. On-plot improved	0.77	"Piped into Dwelling" or "Piped to Yard/Plot", and "On Premises" improved water source	HV201, HV235
Sanitation access relative risk		**2013–2014 DHS household file**	**2013–2014 DHS Congo, Dem. Rep.**
A. No, unimproved, and shared	1.00	"Flush or pour-flush toilet: Flush to somewhere else", "Pit Latrine: without slab/ open pit", "Bucket Toilet", "Hanging Toilet/ Hanging Latrine", "No Facility/Bush/Field"	HV205
B. Improved and unshared (excluding sewered house connection)	0.84	"Flush or pour-flush toilet: Flush to septic tank/pit latrine", Flush or pour-flush: don't know where", "Pit Latrine: VIP/with slab", "Composting toilet"	HV205
C. Improved sewered house connection	0.31	"Flush or pour-flush toilet flush to piped sewer system"	HV205, HV225

Note: Reference refers to a variable in the DHS table (e.g., HV201).

various WASH interventions corresponding to the different exposure scenarios, or service levels (Table X.1; Prüss-Ustün et al. 2014)

We assign exposure scenarios based on the coverage of water and sanitation service levels using data from the 2013–2014 Democratic Republic of Congo DHS (See map X.1 for survey sites). We define service levels with a desire to align where possible with the World Bank Access Plus framework and use three service levels for both water and sanitation (Table X.1) that can be combined to describe a number of exposure scenarios with varying degrees of diarrheal disease risk (table 3.3).

Water

We exclude 'point-of-use' water treatment scenarios due to the challenges of estimating adequate compliance and the questionable reliability of the RR estimates. We use three exposure scenarios from the DHS to estimate water source coverage: unimproved water, off-plot or community improved water source, and on-plot improved (including piped) water source (Table X.1). Water sources were grouped into scenarios using the DHS household-level data and JMP MDG water ladder definitions. Water source coverage was then estimated at the cluster ("community") level using all households and then combined with the child-level data and used to calculate the exposure index.

Sanitation

We use all three exposure scenarios for sanitation proposed by Wolf and colleagues (Prüss-Ustün et al. 2014): unimproved sanitation (including open defecation), improved no sewer (on-site), and sewer connection (reticulated, off-site). Each scenario was defined using the classification of toilet type and reported household sharing from the DHS household-level data. Sanitation coverage was then estimated at the cluster ("community") level using all households and combined with child-level data to calculate the exposure index.

We derived sanitation definitions in accordance with the JMP MDG sanitation ladder. Category A included open defecation and unimproved, any shared improved toilet or latrine and pour/flush toilets that flush to "somewhere else." Category B includes unshared improved toilets or latrines and pour/flush toilets that flush to "don't know where." Category C includes unshared pour/flush toilets that are connected to piped sewer.

Table X.2: Exposure Scenarios and Assigned Relative Risks from Literature Estimates

1	No improved water access, no improved sanitation access	A	1.00	A	1.00	1.00
2	Improved off-plot water access, no improved sanitation access	B	0.89	A	1.00	0.89
3	No improved water access, improved sanitation access	A	1.00	B	0.84	0.84
4	Improved off-plot water access, improved sanitation access	B	0.89	B	0.84	0.75
5	Improved on premises, improved sanitation access	C	0.77	B	0.84	0.65
6	Improved on premises, sewered sanitation	C	0.77	C	0.31	0.24

Note: Relative risk values are from Wolf et al. 2014.

Exposure index

Scores for the exposure index are calculated individually for each child based on the combined RRs of each water and sanitation access scenario (table X.2; equation X.1). The value for each child is based on the household's access to water and sanitation facilities. Exposure values are then estimated for each child, then averaged by cluster using survey weights included in DHS datasets. After calculating the exposure index, we then adjusted it to excess exposure risk due to inadequate WASH by subtracting 1.00 from the relative risk value.

$$ExpIndex_i = SanRR \cdot WatRR \quad (X.1)$$

Other Exposure Risk Factors

In addition to water and sanitation scenarios, we present DHS data to characterize disparities in other hygiene factors related to diarrheal disease (table X.3). While these are important for exposure, their contribution to exposure risk has not been characterized through rigorous studies. However, this does not undermine how important they are for limiting child exposure to diarrheal disease.

Improved hand washing and safe water treatment are defined using the household-level DHS data (table X.3). A household has improved handwashing facilities if they meet three criteria present in the household-level data in the DHS: (i) having a designated place for hand washing that is stocked with (ii) water and (iii) soap, mud, or ash. Improved or safe water treatment is defined by treating household water with an effective method for decontaminating drinking water.

Table X.3: Definitions of Other Exposure Risk Factors

Input	Description	Reference
Handwashing	**2013–2014 DHS Household File**	**2013–2014 DHS Congo, Dem. Rep.**
Improved	Designated place for handwashing, water with soap, mud, or ash present	HV230a-b, HV232a–b
Unimproved	Absence of either place, water, or soap/ash/mud	HV230a-b, HV232a–b
Water treatment	**2013–2014 DHS Household File**	**2013–2014 DHS Congo, Dem. Rep.**
Safe	"Boil", "Bleach/chlorine", "Solar disinfectant", "Water filter"	HV237a-b, d-e
Unsafe	"Strain through cloth", "Let it stand", "Other", "Don't know"	HV237c, f, x, z
Child stool disposal	**2013–2014 DHS Child File**	**2013–2014 DHS Congo, Dem. Rep.**
Improved	Safe disposal into improved toilet or latrine (Category B or C)	V465 and V116
Safe	"Child used latrine/toilet" or "Put/rinsed in latrine or toilet"	V465
Unimproved	"Put/rinsed into drain or ditch", "Thrown in garbage", "Buried", "Left in the open", "Other"	V465
Population density	**GPW 2015 population per square kilometer adjusted with UN Population projections**	**GPW**
Population density without sanitation	DHS cluster improved sanitation coverage (Category B or C) and GPW 2015 estimates*	HV205 and GPW

Safe or improved child stool disposal is defined using the child-level DHS data. Improved child stool disposal is when the respondent reports that the child either directly uses an improved toilet facility or child stool is rinsed or disposed into an improved toilet facility (table X.3).

Population density estimates from the Gridded Population of the World (GPW) were used to assess the effects of community-level sanitation (Wof et al. 2014). These provide 1 square kilometer resolution estimates of population density. We used GPW estimates that have been adjusted using UN population projections. We overlaid DHS cluster locations on GPW population density raster maps and extracted density estimates for each cluster. We also calculated "population density without sanitation" as a proxy measure for the relative amount of human waste potentially being released into the environment. We used the product of improved sanitation coverage and population density as a measure of community-level contamination. In order to calculate this variable, population density cluster estimates were combined with cluster improved sanitation (Category B and C, table X.1) coverage to describe the co-distribution of individual child and community sanitation risk (table X.3).

Defining Susceptibility Risk Factors

The model includes three risk factors related to susceptibility of diarrheal disease and mortality.

These include acquisition of susceptibility-related micronutrients (vitamin A), effective treatment (for example, oral rehydration), and undernutrition assessed by child weight-for-age (WFA) (table X.4).

Undernutrition

For undernutrition, we use RRs from Caulfield et al., which estimated the RR of cause-specific mortality (including diarrhea) for different levels of stunting (low height-for-age), wasting (low weight-for-height), and underweight (WFA).

We estimate RRs based on WFA *Z*-scores recorded for under five children in the child-level DHS data (table X.4). RRs are assigned to different levels of WFA based on standard deviations (SD) below the global mean of the *Z*-score distribution (−1 to −2 SD, −2 to −3 SD, and less than −3 SD) compared to normal (greater than −1 SD). For the diarrheal risk model, we use the estimates for low WFA on diarrheal mortality as a likely measure of long- and short-term undernutrition effects. We use reported RRs for each level to estimate a piece-wise linear risk function that provides a continuous estimate of excess risk as WFA Z-scores decline (table X.4).

Oral Rehydration Treatment

There is substantial evidence of the effect of oral rehydration treatment (ORT) on the severity and duration of diarrhea. Based on 157 studies, Munos et al. (2010) estimated a 93 percent reduction in diarrhea mortality with ORT use (pre-packaged or home remedy). We combine this estimate with an estimated probability of receiving ORT, calculated using child-level DHS data (table X.4). Data on ORT are only available for children who have had a diarrheal episode in the previous two weeks. If analyses were restricted to these observations, the coverage of analyses would become very sparse, and likely bias or underestimate the occurrence of diarrhea. Rather than including whether a child received ORT for a recent diarrheal episode (during the last two weeks), we estimate the propensity for receiving ORT given household wealth quintile, maternal education, region, setting, and child age. Values for children without a recent episode are imputed using a logistic regression model built on data from children who did have an episode. Imputing values for all children results in a more widespread estimate of the likelihood of receiving ORT.

Table X.4: Model Parameters for the Susceptibility Index

Input	Relative risk	Description
Child underweight		
Normal	–	WFA Z-score > –1 SD from the mean
Mild risk	2.32	WFA Z-score –1 to –2 SD from the mean
Moderate risk	5.39	WFA Z-score –2 to –3 SD from the mean
High risk	12.50	WFA Z-score < –3 SD from the mean
Oral rehydration treatment		
Does not receive oral rehydration		
Receives oral rehydration	0.07	Protective, reduces risk of mortality by 93 percent
Vitamin A dose		
Received vitamin A dose	–	
Diarrheal mortality risk reduction from receiving ORT	0.72	Protective, reduces risk of mortality by 28 percent

Table X.5: Summary of Susceptibility Index Calculation

Risk factor	Relative risk description	Data source	Calculation
Underweight	Having a low weight-for-age (WFA) significantly increases a child's risk of dying from diarrheal disease. WFA is assessed on how far a child is above or below the international standard. The more standard deviations below the average, the greater the risk.	WFA is collected and reported in the DHS.	Relative risk for different categories are linearized to create an individual value for the child (from 1 to 12.5)
Oral rehydration	Receiving timely rehydration can greatly reduce the mortality from diarrheal disease (by 93 percent). The relative risk of diarrheal mortality for ORT is 0.07 (RR_ORT).	DHS has information on whether children receive ORT (PrORT) following diarrhea for some children. We estimate the probability of receiving ORT for all children using data from those that have it (adjusting for age, sex, wealth, and region).	Based on the probability of getting ORT and the relative risk, ranging from 0.07 to 1.0. 1 – (PrORT × (1 – RR_ORT))
Vitamin A	Receiving vitamin A supplementation has been shown to reduce the risk of diarrheal mortality in children. The relative risk is 0.72 (a 28 percent reduction) (RR_vitA).	DHS has information on whether children have received vitamin A supplementation (vit_A).	Based on whether they received vitamin A and its protective effect. 1 – (vit_A × (1 – RR_vitA))

Vitamin A

Imdad et al. examined the effect of vitamin A supplementation on diarrheal mortality, as well as outcomes related to pneumonia and measles. Based on 12 studies with data on diarrhea-specific mortality, they estimated a pooled effect of ~30 percent reduction due to vitamin A supplementation (RR = 0.70; CI: 0.58–0.86) among children 6–59 months of age. This estimate is incorporated in the susceptibility estimates using child-level DHS data on whether or not the child received a vitamin A dose.

Susceptibility Index

Scores for the susceptibility index are calculated individually for each child based on the combined RRs of each of the three susceptibility factors (table X.5). The susceptibility index ($SusIndex_i$) is designed to be proportional to the excess risk associated with all of the factors (equation X.2).

$$SusIndex_i = \prod_k \sum_{i,j} RR_{j,k} . RiskFactor_{i,j,k} \quad \text{(X.2)}$$

Where $RR_{j,k}$ is the relative risk associated with the j^{th} level of risk factor k. $RiskFactor_{i,j,k}$ is the level of that risk factor for individual i. For vitamin A supplementation, there is only two levels (yes or no) and $RiskFactor_{i,j,k}$ serves as a dummy variable. For the other risk factors, the levels are continuous. Susceptibility values are estimated for each child subpopulation using appropriate survey weights included in DHS datasets.

Combined Risk Index

Susceptibility ($SusIndex_i$)and exposure risk ($ExpIndex_i$) are combined into the overall risk index ($RiskIndex_i$), which is simply the product of the two indices (Equation X.3). Risk index scores are calculated individually for each child under five years of age and then aggregated into subpopulation estimates.

$$RiskIndex_i = ExpIndex_i \cdot SusIndex_i \quad \text{(X.3)}$$

Data Analyses[1]

Data on the distribution of diarrheal susceptibility and exposure risk factors comes from available DHS surveys. DHSs are implemented countrywide in middle- to low-income countries and survey a wide range of health and socioeconomic characteristics. Surveys are released with data on geographic locations and include both household- and individual-level datasets. Households are selected using stratified sampling methods that require accounting for complex survey design. The following sections describe the graphs and figures that will be used to display the analysis.

Density Plots

These graphs show the distributions of variables of interest using probability densities. The area under each curve is equal to one, and represents the relative density of probability that a member of the wealth quintile has the corresponding value along the *x*-axis.

Concentration Curves

These graphs show the distributions of outcomes across a ranked cumulative fraction of the population, in this study, socioeconomic status. The *x*-axis shows the cumulative wealth fraction

from the poorest percentiles on the left, to the entire population on right and shows the fraction of a given outcome (*y*-axis) associated with the population up to each cumulative wealth level. This is plotted against a 45° line of equity, where the poorest 40 percent have 40 percent of outcomes, extending all the way up the wealth continuum. While they do not show actual coverage values for risk factors, they do highlight where disparities in risk factor coverage are most prominent.

Scatterplot Matrices

The lower half of these figures show a series of pairwise *x*–*y* scatter plots showing the co-distribution of different WASH risk factors and indices for urban and rural children. The upper half shows two-dimensional contour plots of the pairwise co-distributions of variables and indices from the WASH-PRM. Many of the individual risk factors are categorical and therefore not easily represented. In these cases, scatters show the cluster-level proportions and means, rather than individual values.

Poverty and Economic Status

Asset-based wealth and consumption metrics both reflect urban and rural poverty differently. The differences in both lifestyle and access to assets between urban and rural populations can be masked when wealth quintiles are calculated at a national level. Asset-based wealth metrics rely on individual goods (such as bicycles) or construction materials (such as thatch roofs), which have very different meaning and value in rural versus urban settings. National quintiles can obscure the condition of the urban poor, who are grouped into the third or fourth national quintiles. While their assets may group them into higher wealth quintiles as compared to rural populations, they may not experience a higher standard of living equal to their higher ranking. Asset-based indices (as are used in DHS to determine household wealth) result in rural households being grouped into the middle and lower national quintiles, while urban households are grouped into the middle and upper quintiles. Failing to account for urban and rural differences can obscure important underlying patterns between wealth and health. We computed national, urban, and rural wealth quintiles, and ranked urban and rural households separately by wealth quintiles. The categorization of quintiles for urban and rural populations is based on the distribution of the asset scores for the urban and rural populations, respectively, rather than the national distribution, thus they must not be interpreted as equivalent.

Geospatial analyses

One of the key objectives of the WASH-PRM is to show the geographic distribution and co-distribution of risk factors and impact. This includes mapping of individual risk factors and cumulative measures (e.g., exposure, susceptibility, and risk indices). Our maps identify regions that experience high levels of exposure, susceptibility, and diarrheal risk and other important outcomes. We show these outcomes at national and regional scales, and for different economic levels (B40 and T60).

We interpolated exposure, susceptibility, and risk indices for the national-level maps, as well as for the B40 and T60. We calculated cluster-level averages of the three indices. Using ARCGIS 10.2.2, we utilized empirical Bayesian krigingto interpolate a high-resolution (5 square kilometers) risk surface. Standard kriging approaches use a regression-type linear model to predict values at unmeasured locations on a surface using an average of values near the point in question. Empirical Bayesian kriging uses the underlying sample distribution to inform the model's priors and covariance functions, whereas most other kriging measures assume an underlying Gaussian distribution, which is often not the case in datasets. These high-resolution maps provide an initial rapid assessment of important trends in diarrheal disease-related factors.

DALY Burden of Inadequate WASH

The WASH-PRM estimates the distribution of child diarrhea and enteric infections due to inadequate WASH. The estimates also account for variability in child susceptibility through undernutrition or lack of medical care. These have been expressed above as measures of the risk index. However, in this section these estimates are translated into the more commonly used measures of DALYs, developed and used by the Global Burden of Disease project (GBD).

DALYs are a common health metric that combines both the years of life lost due to a particular cause or risk factor with the years lived with disability. For diarrhea and enteric disease among children under five years of age, the vast majority (approximately 90 percent) of the DALY burden is YLL due to premature mortality. A single DALY can be considered as one year of healthy life lost. As a summary measure that can be calculated across diverse causes or risk factors, including those that might cause death (such as road traffic accidents) and/or those which do not death but may cause chronic disability (e.g., back pain, or trichiasis). As such, DALYs permit comparison between diverse health conditions and provide a useful summary statistic of disease burden for a given population.

Here, we use DALYs to provide a summary estimate for the distribution of the enteric disease burden attributable to inadequate WASH by subpopulation groups. For this exercise, we use DALY estimates from the 2013 GBD which are available online.

Health burden causes are broken down in the GBD into different categories of communicable and non-communicable diseases. Here we use the estimates for diarrheal disease (category A.2.1 from the GBD data portal website; see reference and intestinal infectious diseases (category A.2.2 from GBD data portal website). It is important to point out that this captures the burden of short-term morbidity and mortality, but does not account for any potential of enteric infections on undernutrition or long-term consequences.

We start by translating the WASH-PRM risk index into a DALY burden rate (DALYs per 100,000 children). The WASH risk index represents the relative *excess* risk associated with inadequate WASH and the first step is to convert it into a measure of overall risk of diarrhea and enteric infections (and not just the excess due to poor WASH). This involves recalculating an overall exposure index that is not adjusted for the excess risk. This is done by using the original relative risk numbers from the literature and not subtracting 1 from the RR to create an excess RR. This has the effect of turning the exposure index (risk index) into a measure of the overall enteric disease risk, rather than just the portion attributable to inadequate WASH.

The second step is to convert this revised enteric risk index into a DALY equivalent. We make the assumption that the relative distribution of the risk index is an appropriate estimate of the distribution of the DALY burden. Using the GBD estimate as our national burden envelope, we create a risk-burden multiplier using the following equation:

$$RBMult = \frac{NatEnterDALY}{EntRiskInd_i} \tag{X.4}$$

This establishes a ratio between risk index and DALY burden that maintains the national GBD burden estimate. We then use the multiplier to estimate an individual-level expected DALY burden for each child. These values can then the aggregated by geographic and economic subpopulations.

$$EntDALY_i = RBMult \cdot EntRiskInd_i \tag{X.5}$$

$$WASHDALY_i = RBMult \cdot WASHRiskind_i \tag{X.6}$$

$EntDALY_i$ represents the burden for individual *i* from diarrheal and enteric infections based on the individual exposure and susceptibility variables. The sum of $EntDALY_i$ over the population

is the same as the GBD diarrheal and enteric infection burden. $WASHDALY_i$ represents the portion of this burden associated with inadequate WASH service levels. As with the GBD burden, these individual estimates are rates expressed as DALYs per 100,000 children.

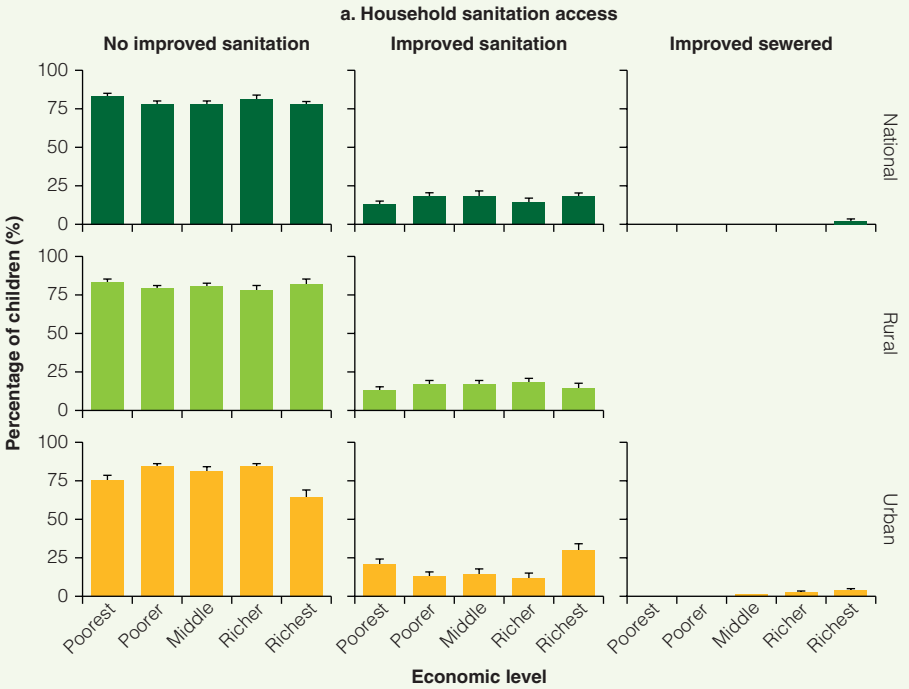
These burden estimates for individual children are then aggregated to subpopulation levels (e.g., region, urban vs. rural residence, and wealth quintile) using survey statistics as above. The appropriately weighted means for the subpopulations represent the expected DALYs per 100,000 children per year. For these measures, we focus on the distribution of the total enteric burden and burden associated with inadequate WASH.

Box X.2: Use of National, Urban, and Rural Wealth Quintiles

Use of National, Urban, and Rural Wealth Quintiles

Figure BX.2.1 presents data by wealth quintile in different ways. National quintiles are the easiest to understand, with all households being divided into groups representing 20% of the population. This is a standard way to describe the bottom 20 (B20) or bottom 40 (B40), and top 60 (T60). One of the challenges with national groupings is that the poorest urban households are often grouped into the middle or fourth quintile based on their housing characteristic, which may overstate their wealth. Similarly, some of the richest rural households are categorized as the middle quintile.

Figure BX.2.1: Distribution of Water and Sanitation Service Levels, by Economic Level (Wealth Quintile) for National, Rural, and Urban Populations of Children under Five



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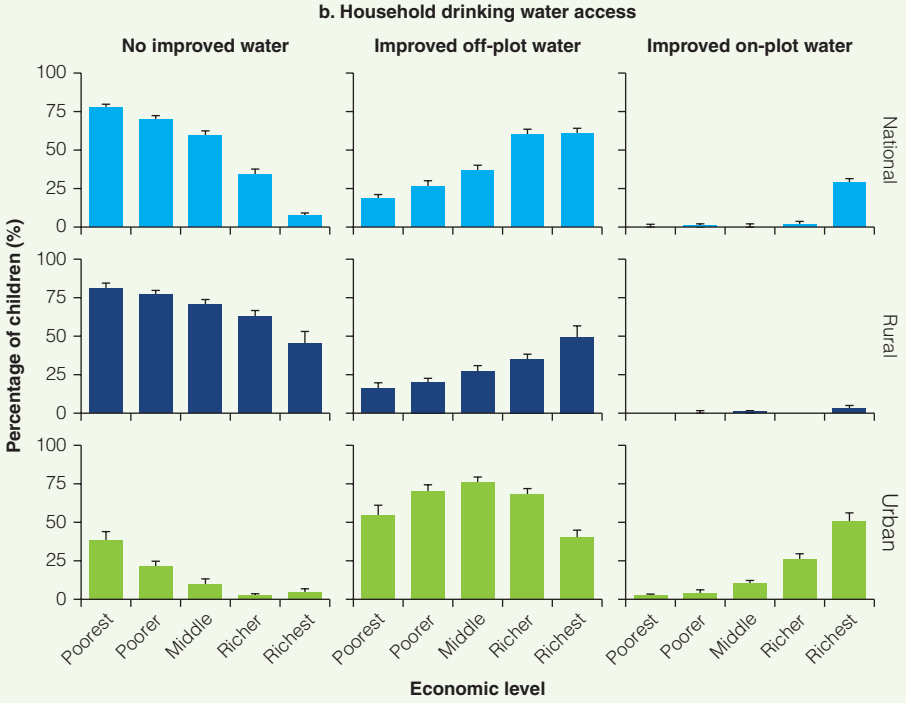
Box X.2: Continued

Figure BX.2.1 Continued



Source: DRC DHS, 2013–14

We calculate rural and urban quintiles separately by first dividing the population into urban and rural and then ranking these two sub-populations by wealth score and finally segmenting into quintiles. Separating urban and rural quintiles allows us to identify inequalities within the urban and rural sub-populations that might otherwise be missed.

Note

1. All statistical estimates presented and imputations were calculated and combined into the WASH-PRM using complex survey design in STATA 14 (StatCorp LP, College Station, TX). All data representations in plots were made in R statistical software using the ggplot2 package, authored by Hadley Wickham, and associated extensions. All maps were rendered in ArcGIS 10.22 (ESRI, Redlands, CA, USA) using model outputs.

References

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Appendix Y
Participants in Democratic Republic of Congo WASH Poverty Diagnostic Review in Kinshasa, November 23, 2016

Table Y.1: Participants in WASH Poverty Diagnostic Review Meeting in Kinshasa (November 23, 2016)

#	Name	Organization	Title
1.	Mme Charlotte Bitulu	ONG ADIR	Chargée de l'Organisation Commerciale
2.	Mme Pascaline Mbangu	DAS/MECNDD	Directrice
3.	M. Munenda Kimankinda	REGIDESO	Directeur
4.	M. Charles Kamanga Nsenda Lukusa	Cadre de Concertation/ Eau	Point Focal
5.	M. Deo Mirindi	MSH/PROSANI	Conseiller
6.	Ir. Jean Lutota	CPAEHA	Secrétaire Exécutif Provincial
7.	M. Simon Masumbuko	Secrétariat CNAEHA	Secrétaire Exécutif
8.	M. Crispin Sedeke	CNAEHA	Chef de Cellule
9.	M. Dominique Sowa Lukono	ADIR	Administrateur
10.	M. Philippe Bosse	AFD	Chargé de Mission
11.	Mme Anette Paschen	GIZ	CTP
12.	M. Timothée Makabu	INS	Directeur des Statistiques Générales et Enquêtes Ménagères
13.	M. Josselin Léon	UNICEF	Spécialiste WASH
14.	Franck Abeille	UNICEF	Head of WASH

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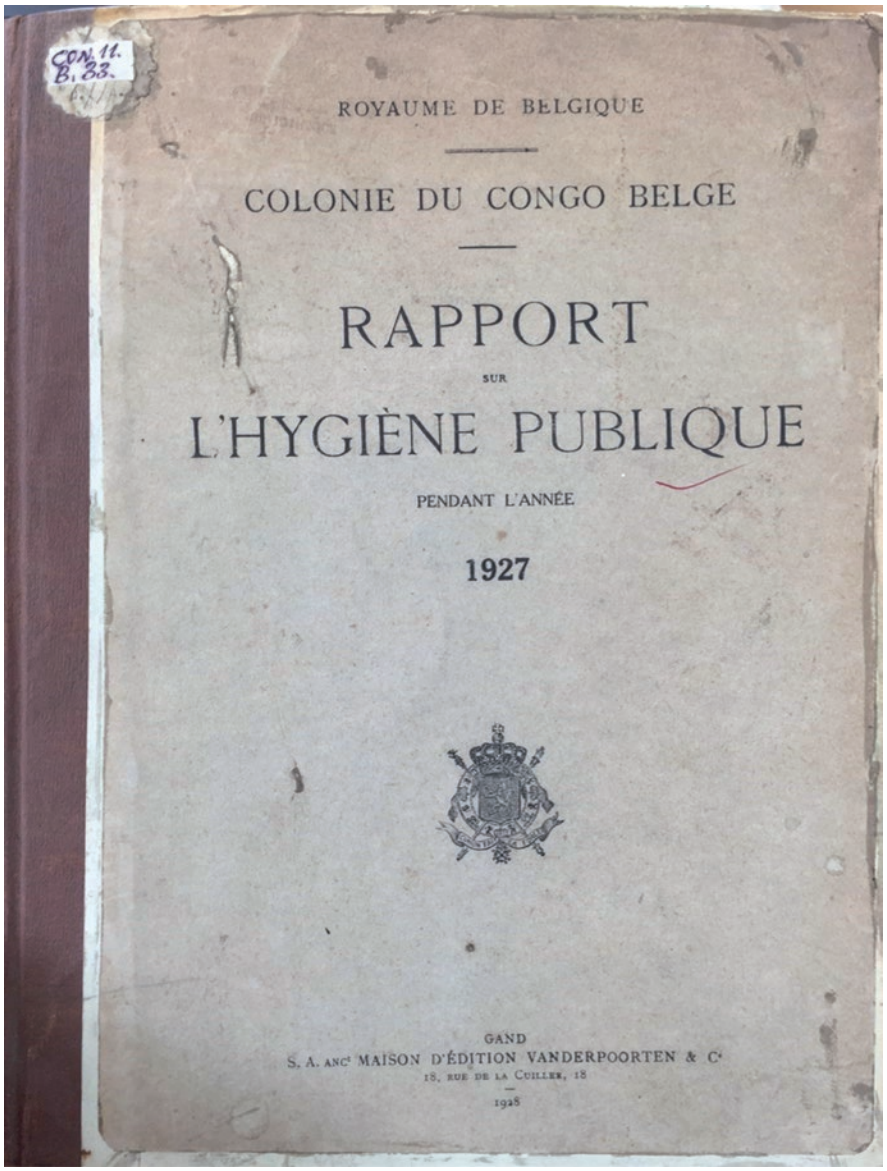
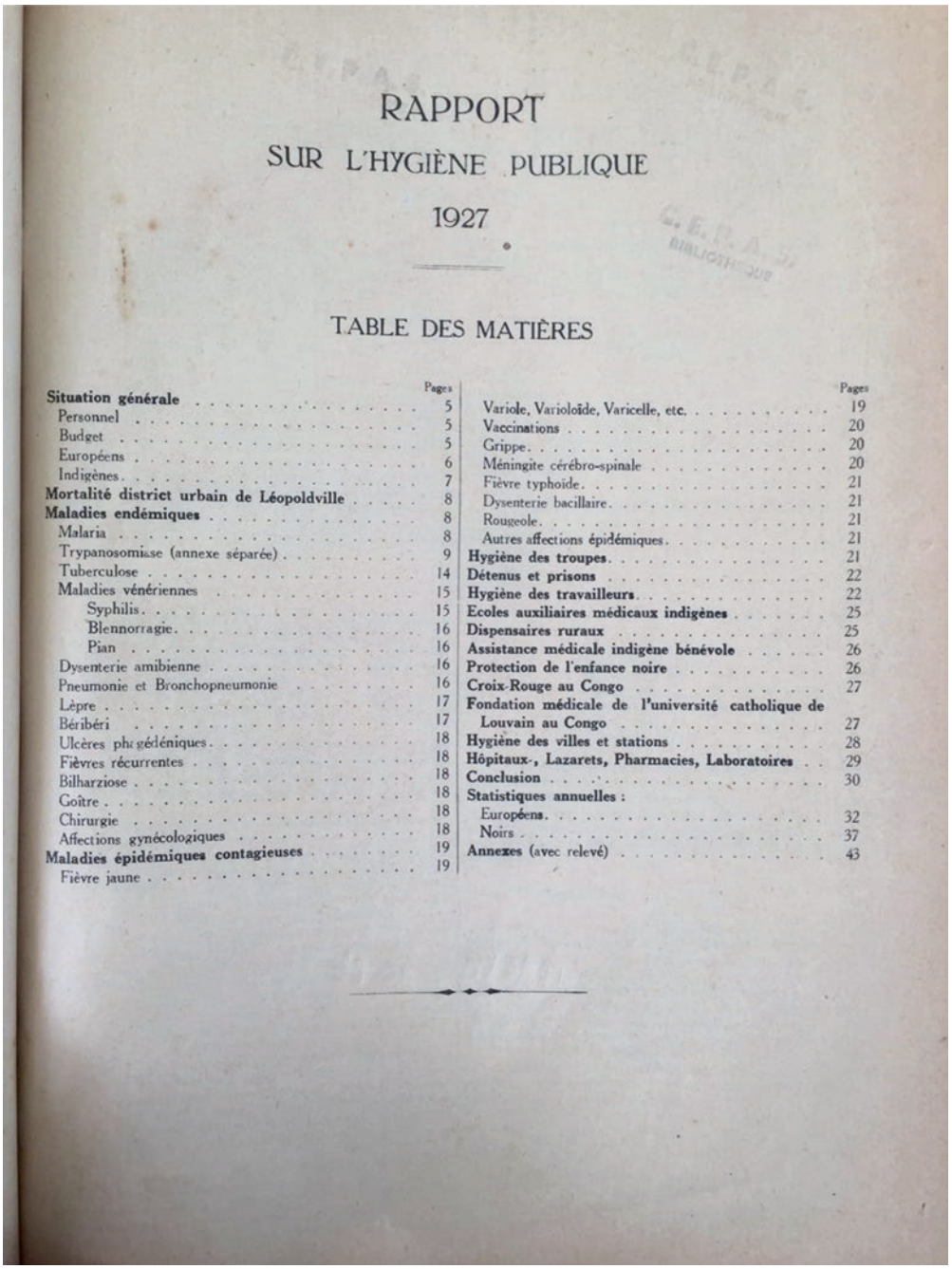
Table Y.1: continued

#	Name	Organization	Title
15.	Mme Tiphaine Valas	HYDROCONSEIL	Experte EHA-Consultante
16.	Mme Emmanuelle Guillou	HYDROCONSEIL	Experte EHA
17.	M. Jean Louis Bongungu	CEP-O/REGIDESO	Coordonnateur
18.	M. Stephen Jones	Consortium WASH/ Concern World Wide	Directeur
19.	Dr. Mavard Kwengani	MSP/ Direction Hygiène	Directeur
20.	Maximilian Leo Hirn	Banque mondiale	Economiste
21.	Aude-Sophie Rodella	Banque mondiale	Economiste Principale

Appendix Z
Key Extracts from Report on Public Hygiene by the Belgian Colonial Government



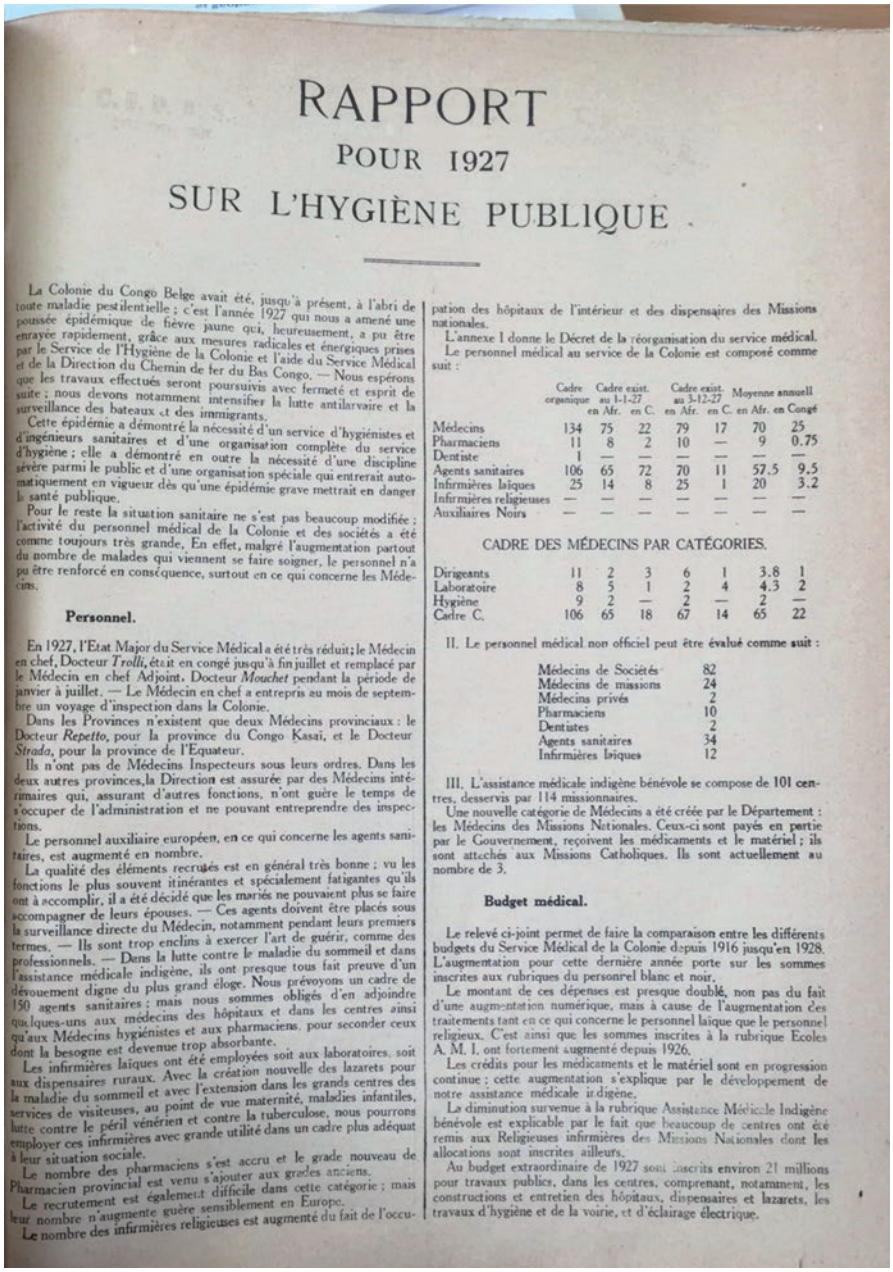


RAPPORT

SUR L'HYGIÈNE PUBLIQUE

1927

TABLE DES MATIÈRES



RAPPORT
POUR 1927
SUR L'HYGIÈNE PUBLIQUE

La Colonie du Congo Belge avait été, jusqu'à présent, à l'abri de toute maladie pestilentielle ; c'est l'année 1927 qui nous a amené une poussée épidémique de fièvre jaune qui, heureusement, a pu être enrayée rapidement, grâce aux mesures radicales et énergiques prises par le Service de l'Hygiène de la Colonie et l'aide du Service Médical et de la Direction du Chemin de fer du Bas Congo. — Nous espérons que les travaux effectués seront poursuivis avec fermeté et esprit de suite ; nous devons notamment intensifier la lutte antilarvaire et la surveillance des bateaux et des immigrants.

Cette épidémie a démontré la nécessité d'un service d'hygiénistes et d'ingénieurs sanitaires et d'une organisation complète du service d'hygiène ; elle a démontré en outre la nécessité d'une discipline sévère parmi le public et d'une organisation spéciale qui entrerait automatiquement en vigueur dès qu'une épidémie grave mettrait en danger la santé publique.

Pour le reste la situation sanitaire ne s'est pas beaucoup modifiée ; l'activité du personnel médical de la Colonie et des sociétés a été comme toujours très grande, En effet, malgré l'augmentation partout du nombre de malades qui viennent se faire soigner, le personnel n'a pu être renforcé en conséquence, surtout en ce qui concerne les Médecins.

Personnel.

En 1927, l'Etat Major du Service Médical a été très réduit ; le Médecin en chef, Docteur *Trolli*, était en congé jusqu'à fin juillet et remplacé par le Médecin en chef Adjoint. Docteur *Mouchet* pendant la période de janvier à juillet. — Le Médecin en chef a entrepris au mois de septembre un voyage d'inspection dans la Colonie.

Dans les Provinces n'existent que deux Médecins provinciaux : le Docteur *Repetto*, pour la province du Congo Kasaï, et le Docteur *Strada*, pour la province de l'Equateur.

Ils n'ont pas de Médecins Inspecteurs sous leurs ordres. Dans les deux autres provinces, la Direction est assurée par des Médecins intérimaires qui, assurant d'autres fonctions, n'ont guère le temps de s'occuper de l'administration et ne pouvant entreprendre des inspections.

Le personnel auxiliaire européen, en ce qui concerne les agents sanitaires, est augmenté en nombre.

La qualité des éléments recrutés est en général très bonne ; vu les fonctions le plus souvent itinérantes et spécialement fatigantes qu'ils ont à accomplir, il a été décidé que les mariés ne pouvaient plus se faire accompagner de leurs épouses. — Ces agents doivent être placés sous la surveillance directe du Médecin, notamment pendant leurs premiers termes. — Ils sont trop enclins à exercer l'art de guérir, comme des professionnels. — Dans la lutte contre le maladie du sommeil et dans l'assistance médicale indigène, ils ont presque tous fait preuve d'un dévouement digne du plus grand éloge. Nous prévoyons un cadre de 150 agents sanitaires ; mais nous sommes obligés d'en adjoindre quelques-uns aux médecins des hôpitaux et dans les centres ainsi qu'aux Médecins hygiénistes et aux pharmaciens, pour seconder ceux dont la besogne est devenue trop absorbante.

Les infirmières laïques ont été employées soit aux laboratoires, soit aux dispensaires ruraux. Avec la création nouvelle des lazarets pour la maladie du sommeil et avec l'extension dans les grands centres des services de visiteuses, au point de vue maternité, maladies infantiles, lutte contre le péril vénérien et contre la tuberculose, nous pourrons employer ces infirmières avec grande utilité dans un cadre plus adéquat à leur situation sociale.

Le nombre des pharmaciens s'est accru et le grade nouveau de Pharmacien provincial est venu s'ajouter aux grades anciens.

Le recrutement est également difficile dans cette catégorie ; mais leur nombre n'augmente guère sensiblement en Europe.

Le nombre des infirmières religieuses est augmenté du fait de l'occupation des hôpitaux de l'intérieur et des dispensaires des Missions nationales.

L'annexe I donne le Décret de la réorganisation du service médical.

Le personnel médical au service de la Colonie est composé comme suit :

	Cadre organique	Cadre exist. au 1-1-27 en Afr.	en C.	Cadre exist. au 3-12-27 en Afr.	en C.	Moyenne annuell en Afr.	en Congé
Médecins	134	75	22	79	17	70	25
Pharmaciens	11	8	2	10	—	9	0.75
Dentiste	1	—	—	—	—	—	—
Agents sanitaires	106	65	72	70	11	57.5	9.5
Infirmières laïques	25	14	8	25	1	20	3.2
Infirmières religieuses	—	—	—	—	—	—	—
Auxiliaires Noirs	—	—	—	—	—	—	—

CADRE DES MÉDECINS PAR CATÉGORIES.

Dirigeants	11	2	3	6	1	3.8	1
Laboratoire	8	5	1	2	4	4.3	2
Hygiène	9	2	—	2	—	2	—
Cadre C.	106	65	18	67	14	65	22

II. Le personnel médical non officiel peut être évalué comme suit :

Médecins de Sociétés	82
Médecins de missions	24
Médecins privés	2
Pharmaciens	10
Dentistes	2
Agents sanitaires	34
Infirmières laïques	12

III. L'assistance médicale indigène bénévole se compose de 101 centres, desservis par 114 missionnaires.

Une nouvelle catégorie de Médecins a été créée par le Département : les Médecins des Missions Nationales. Ceux-ci sont payés en partie par le Gouvernement, reçoivent les médicaments et le matériel ; ils sont attachés aux Missions Catholiques. Ils sont actuellement au nombre de 3.

Budget médical.

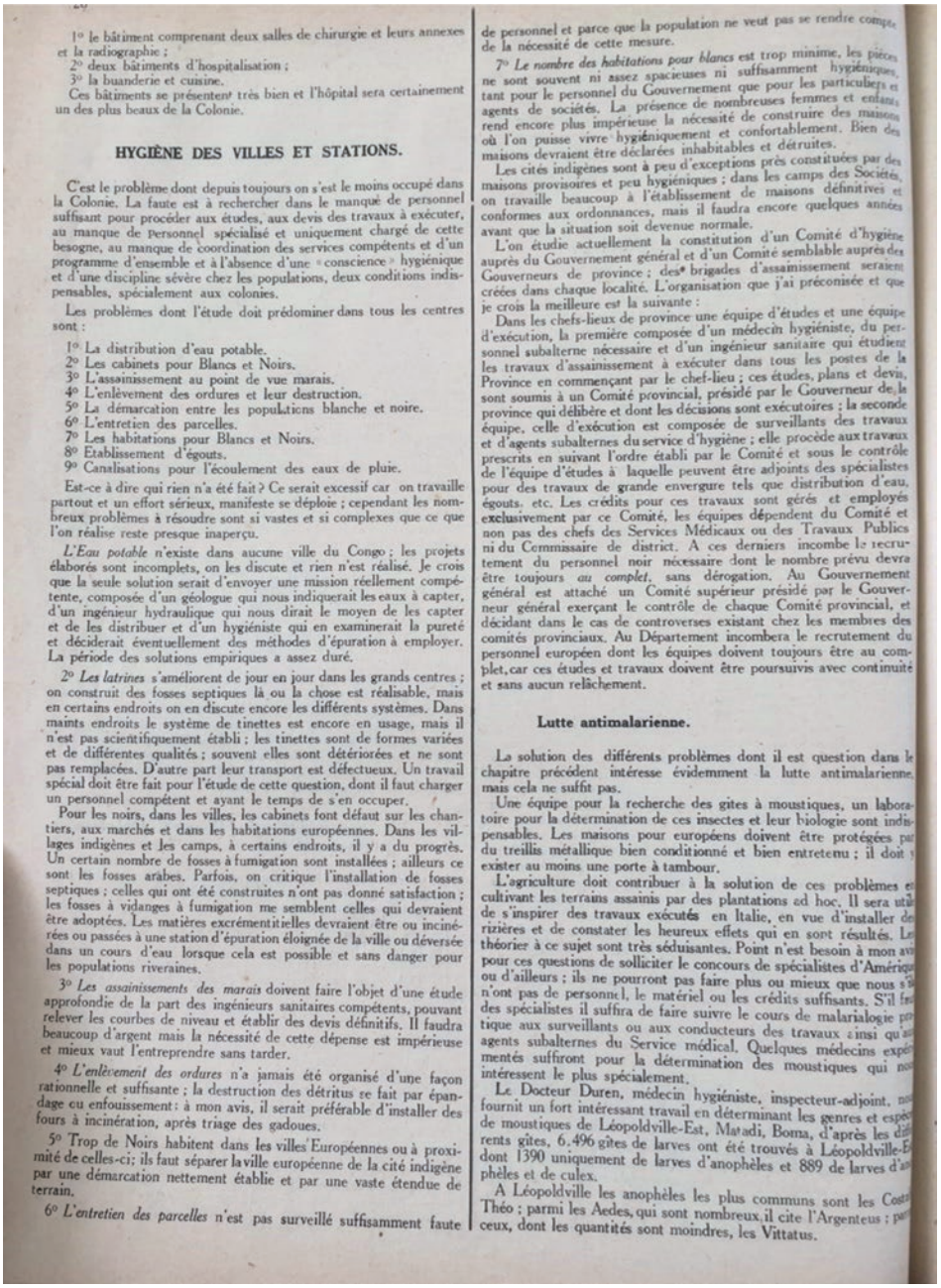
Le relevé ci-joint permet de faire la comparaison entre les différents budgets du Service Médical de la Colonie depuis 1916 jusqu'en 1928. L'augmentation pour cette dernière année porte sur les sommes inscrites aux rubriques du personnel blanc et noir.

Le montant de ces dépenses est presque doublé, non pas du fait d'une augmentation numérique, mais à cause de l'augmentation des traitements tant en ce qui concerne le personnel laïque que le personnel religieux. C'est ainsi que les sommes inscrites à la rubrique Ecoles A. M. I. ont fortement augmenté depuis 1926.

Les crédits pour les médicaments et le matériel sont en progression continue ; cette augmentation s'explique par le développement de notre assistance médicale indigène.

La diminution survenue à la rubrique Assistance Médicale Indigène bénévole est explicable par le fait que beaucoup de centres ont été remis aux Religieuses infirmières des Missions Nationales dont les allocations sont inscrites ailleurs.

Au budget extraordinaire de 1927 sont inscrits environ 21 millions pour travaux publics, dans les centres, comprenant, notamment, les constructions et entretien des hôpitaux, dispensaires et lazarets, les travaux d'hygiène et de la voirie, et d'éclairage électrique.



1° le bâtiment comprenant deux salles de chirurgie et leurs annexes et la radiographie ;
2° deux bâtiments d'hospitalisation ;
3° la buanderie et cuisine.

Ces bâtiments se présentent très bien et l'hôpital sera certainement un des plus beaux de la Colonie.

HYGIÈNE DES VILLES ET STATIONS.

C'est le problème dont depuis toujours on s'est le moins occupé dans la Colonie. La faute est à rechercher dans le manque de personnel suffisant pour procéder aux études, aux devis des travaux à exécuter, au manque de personnel spécialisé et uniquement chargé de cette besogne, au manque de coordination des services compétents et d'un programme d'ensemble et à l'absence d'une « conscience » hygiénique et d'une discipline sévère chez les populations, deux conditions indispensables, spécialement aux colonies.

Les problèmes dont l'étude doit prédominer dans tous les centres sont :

1° La distribution d'eau potable.
2° Les cabinets pour Blancs et Noirs.
3° L'assainissement au point de vue marais.
4° L'enlèvement des ordures et leur destruction.
5° La démarcation entre les populations blanche et noire.
6° L'entretien des parcelles.
7° Les habitations pour Blancs et Noirs.
8° Etablissement d'égouts.
9° Canalisations pour l'écoulement des eaux de pluie.

Est-ce à dire qui rien n'a été fait ? Ce serait excessif car on travaille partout et un effort sérieux, manifeste se déploie ; cependant les nombreux problèmes à résoudre sont si vastes et si complexes que ce que l'on réalise reste presque inaperçu.

L'Eau potable n'existe dans aucune ville du Congo ; les projets élaborés sont incomplets, on les discute et rien n'est réalisé. Je crois que la seule solution serait d'envoyer une mission réellement compétente, composée d'un géologue qui nous indiquerait les eaux à capter, d'un ingénieur hydraulique qui nous dirait le moyen de les capter et de les distribuer et d'un hygiéniste qui en examinerait la pureté et déciderait éventuellement des méthodes d'épuration à employer. La période des solutions empiriques a assez duré.

2° *Les latrines* s'améliorent de jour en jour dans les grands centres ; on construit des fosses septiques là ou la chose est réalisable, mais en certains endroits on en discute encore les différents systèmes. Dans maints endroits le système de tinettes est encore en usage, mais il n'est pas scientifiquement établi ; les tinettes sont de formes variées et de différentes qualités ; souvent elles sont détériorées et ne sont pas remplacées. D'autre part leur transport est défectueux. Un travail spécial doit être fait pour l'étude de cette question, dont il faut charger un personnel compétent et ayant le temps de s'en occuper.

Pour les noirs, dans les villes, les cabinets font défaut sur les chantiers, aux marchés et dans les habitations européennes. Dans les villages indigènes et les camps, à certains endroits, il y a du progrès. Un certain nombre de fosses à fumigation sont installées ; ailleurs ce sont les fosses arabes. Parfois, on critique l'installation de fosses septiques ; celles qui ont été construites n'ont pas donné satisfaction ; les fosses à vidanges à fumigation me semblent celles qui devraient être adoptées. Les matières excrémentitielles devraient être ou incinérées ou passées à une station d'épuration éloignée de la ville ou déversée dans un cours d'eau lorsque cela est possible et sans danger pour les populations riveraines.

3° *Les assainissements des marais* doivent faire l'objet d'une étude approfondie de la part des ingénieurs sanitaires compétents, pouvant relever les courbes de niveau et établir des devis définitifs. Il faudra beaucoup d'argent mais la nécessité de cette dépense est impérieuse et mieux vaut l'entreprendre sans tarder.

4° *L'enlèvement des ordures* n'a jamais été organisé d'une façon rationnelle et suffisante ; la destruction des détritus se fait par épandage ou enfouissement : à mon avis, il serait préférable d'installer des fours à incinération, après triage des gadoues.

5° Trop de Noirs habitent dans les villes Européennes ou à proximité de celles-ci; ils faut séparer la ville européenne de la cité indigène par une démarcation nettement établie et par une vaste étendue de terrain.

6° *L'entretien des parcelles* n'est pas surveillé suffisamment faute de personnel et parce que la population ne veut pas se rendre compte de la nécessité de cette mesure.

7° *Le nombre des habitations pour blancs* est trop minime, les pièces ne sont souvent ni assez spacieuses ni suffisamment hygiéniques, tant pour le personnel du Gouvernement que pour les particuliers et agents de sociétés. La présence de nombreuses femmes et enfants rend encore plus impérieuse la nécessité de construire des maisons où l'on puisse vivre hygiéniquement et confortablement. Bien des maisons devraient être déclarées inhabitables et détruites.

Les cités indigènes sont à peu d'exceptions près constituées par des maisons provisoires et peu hygiéniques ; dans les camps des Sociétés, on travaille beaucoup à l'établissement de maisons définitives et conformes aux ordonnances, mais il faudra encore quelques années avant que la situation soit devenue normale.

L'on étudie actuellement la constitution d'un Comité d'hygiène auprès du Gouvernement général et d'un Comité semblable auprès des Gouverneurs de province ; des brigades d'assainissement seraient créées dans chaque localité. L'organisation que j'ai préconisée et que je crois la meilleure est la suivante :

Dans les chefs-lieux de province une équipe d'études et une équipe d'exécution, la première composée d'un médecin hygiéniste, du personnel subalterne nécessaire et d'un ingénieur sanitaire qui étudient les travaux d'assainissement à exécuter dans tous les postes de la Province en commençant par le chef-lieu ; ces études, plans et devis, sont soumis à un Comité provincial, présidé par le Gouverneur de la province qui délibère et dont les décisions sont exécutoires ; la seconde équipe, celle d'exécution est composée de surveillants des travaux et d'agents subalternes du service d'hygiène ; elle procède aux travaux prescrits en suivant l'ordre établi par le Comité et sous le contrôle de l'équipe d'études à laquelle peuvent être adjoints des spécialistes pour des travaux de grande envergure tels que distribution d'eau, égouts, etc. Les crédits pour ces travaux sont gérés et employés exclusivement par ce Comité, les équipes dépendent du Comité et non pas des chefs des Services Médicaux ou des Travaux Publics ni du Commissaire de district. A ces derniers incombe le recrutement du personnel noir nécessaire dont le nombre prévu devra être toujours *au complet*, sans dérogation. Au Gouvernement général est attaché un Comité supérieur présidé par le Gouverneur général exerçant le contrôle de chaque Comité provincial, et décidant dans le cas de controverses existant chez les membres des comités provinciaux. Au Département incombera le recrutement du personnel européen dont les équipes doivent toujours être au complet, car ces études et travaux doivent être poursuivis avec continuité et sans aucun relâchement.

Lutte antimalarienne.

La solution des différents problèmes dont il est question dans le chapitre précédent intéresse évidemment la lutte antimalarienne, mais cela ne suffit pas.

Une équipe pour la recherche des gites à moustiques, un laboratoire pour la détermination de ces insectes et leur biologie sont indispensables. Les maisons pour européens doivent être protégées par du treillis métallique bien conditionné et bien entretenu ; il doit y exister au moins une porte à tambour.

L'agriculture doit contribuer à la solution de ces problèmes en cultivant les terrains assainis par des plantations ad hoc. Il sera utile de s'inspirer des travaux exécutés en Italie, en vue d'installer des rizières et de constater les heureux effets qui en sont résultés. La théorie à ce sujet sont très séduisantes. Point n'est besoin à mon avis pour ces questions de solliciter le concours de spécialistes d'Amérique ou d'ailleurs ; ils ne pourront pas faire plus ou mieux que nous s'ils n'ont pas de personnel, le matériel ou les crédits suffisants. S'il faut des spécialistes il suffira de faire suivre le cours de malariologie pratique aux surveillants ou aux conducteurs des travaux ainsi qu'aux agents subalternes du Service médical. Quelques médecins expérimentés suffiront pour la détermination des moustiques qui nous intéressent le plus spécialement.

Le Docteur Duren, médecin hygiéniste, inspecteur-adjoint, nous fournit un fort intéressant travail en déterminant les genres et espèces de moustiques de Léopoldville-Est, Matadi, Boma, d'après les différents gîtes, 6.496 gîtes de larves ont été trouvés à Léopoldville-Est dont 1390 uniquement de larves d'anophèles et 889 de larves d'anophèles et de culex.

A Léopoldville les anophèles les plus communs sont les Costa Théo ; parmi les Aedes, qui sont nombreux, il cite l'Argenteus ; parmi ceux, dont les quantités sont moindres, les Vittatus.

Conclusions.

Les grands problèmes à résoudre, au point de vue médical et hygiénique de la Colonie, sont :

La lutte contre la maladie du sommeil ;

Les mesures d'hygiène et d'assainissement des grands centres ;

L'assistance médicale indigène ;

L'hygiène du travail dans les exploitations agricoles, minières commerciales, travaux de routes, etc. ;

La nourriture et par conséquent la mise au point des questions intéressant le développement de l'agriculture et de l'élevage.

Ces problèmes ne peuvent être résolus que par une étroite collaboration des Services Médicaux, des Travaux Publics, de l'Agriculture, des Affaires Economiques, des Affaires Indigènes et Main d'Œuvre. C'est de la coordination des efforts que dépend l'avenir de la Colonie.

Cette organisation nécessite une intervention des grandes sociétés et des organismes compétents, sans laquelle les seuls efforts du Gouvernement seront toujours inopérants.

Le Conseil Supérieur d'Hygiène Coloniale, institué par le Gouvernement à Bruxelles, est appelé à rendre les plus grands services en s'attachant à résoudre les problèmes développés plus haut. Il pourra établir un programme d'ensemble à appliquer avec persévérance, tenacité et confiance.

Le Médecin en Chef,

(s.) Dr, G. TROLLI.

Appendix AA Restructuring of the CNAEHA - Summary of the Most Important Changes

CNAEA	CNAEHA
General	
Water and Sanitation	Water, Hygiene and Sanitation
Legal entity	Administrative and financial autonomy
The Executive Secretary is nominated by the Ministry of Planning	*The Executive Secretary is nominated by the President of the Republic*
Provincial committees (CPAEA)	*Provincial and territorial committees (CPAEHA and **CTAEHA**)*
Composition of the steering committee and technical commissions	
	Integration of certain ministries, members of the steering committee : Ministry of Higher Education, Economy, etc.
President (Ministry of Planning), first vice-president, (Ministry of Environment), second vice-president (Ministry of Energy)	*President (Ministry of Planning), first vice-president, (Ministry of Environment), second vice-president (Ministry of Energy) and a **third vice-president (Ministry of Health**)*
Absence of the Provincial Health Minister in the provincial committee	*At provincial level, the **Provincial Health Minister** is the forth vice-president of the provincial steering committee*
Absence of representatives of technical and financial partners, sector's civil society and FEC in meetings of the CNAEA Steering Committee	*One representative for every organization without vote in CNEAHA Steering Committee meetings*
REGIDESO, SNHR and SNEL are members of the Steering Committee	*REGIDESO, SNHR and SNEL are members of the technical commissions of the CNAEHA and not members of the Steering Committee*
Mission	
	Additionally to the missions of the former CNAEA, the CNAEHA has two additional missions : • *Alignment of all sectorial interventions following government priorities* • *Coordination of the WASH sector reform*