WASH
Poverty Diagnostic | SERIES

Dire Straits

The Crisis Surrounding Poverty, Conflict, and Water in the Republic of Yemen

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Executive Summary

This report is part of a global set of Water, Sanitation, and Hygiene (WASH) for All diagnostics carried out in countries where WASH services for the poor are deficient and where there might be institutional constraints to improving coverage and services. The Republic of Yemen is an important case because there is an ongoing, violent conflict, a plausibly sharp increase in poverty over the last decade, and the weakest performance on WASH-related indicators in the Middle East and North Africa region.

Analyzing the situation in the Republic of Yemen is significant yet difficult: since 2011, the country has been embroiled in political turmoil, and since 2014, it has been prey to armed and destructive internal conflict. Not only have advances in WASH provisions made over the last decade been halted but also the country has experienced wholesale physical destruction, institutional degradation, and movement of internally displaced people (IDPs) that have contributed to an alarming deterioration in WASH services. In May 2015, the United Nations (UN) placed the Republic of Yemen at level 3 of humanitarian distress, the highest categorization of countries in conflict. About half of the population of about 26.8 million lives in areas directly affected by the conflict (World Bank 2016b). Basic services across the country are on the verge of collapse. According to the Yemen Humanitarian Response Situation Report (Save the Children 2016), 19.4 million people lack clean water and sanitation, including 10.2 million children. According to the World Health Organization (WHO), as of January 24, 2017, 18,194 acute watery diarrhea (AWD) and cholera cases and 99 deaths (case fatality rate [CFR] of 0.5 percent) have been reported in 165 districts. Of these 8,869 (49 percent) are women, while 6,144 (34 percent) are children below five years old. Cholera cases have been rising significantly since, with increased fatalities.

Against this backdrop, this report aims to develop a better understanding of the current picture of poverty and the manner in which it interacts with the levels of WASH access and service delivery in the Republic of Yemen. The report also seeks to analyze the institutional constraints to WASH delivery. The latter is limited in scope and is, for the most part, a preconflict analysis due to in-country security. The work conducted was purely based on desk-research. The objectives of the report are to: (a) provide pointers for how WASH strategies and investments may be recalibrated in the postconflict period to assist both short-term recovery and medium-term structured development; and, (b) provide a blueprint for how short- and medium-term strategies may fit into a longer term vision of universal access to safe water and sanitation, with priority to the poor, while ensuring sustainable stewardship of the country's extremely water scarce resources.

Access to sustainable water and sanitation services (WSS) prior to the conflict that is ensuing today in the Republic of Yemen was already not keeping pace with needs in urban areas, and, the gap between urban and rural areas was wide. Therefore, even while working on the urgent priority needs of emergency reconstruction and rehabilitation today, the challenges identified in this the Republic of Yemen WASH Poverty Diagnostic point to the eventual necessity of looking beyond emergency needs for the medium term and beyond.

The institutional arrangements for the sector will require a mix of the following:

- Considering the stewardship of water as a resource and inter-basin cooperation by either strengthening existing institutions or considering supplemental arrangements, including the National Water Resources Authority (NWRA) and its branches at the governorate level

- Greater coordination across the water-agriculture-energy nexus to maximize efficiency of use, noting in particular that the agriculture sector is using more than 90 percent of the water resources

- Supporting the central agencies involved with WSS including regulatory agencies, as well as their deconcentrated branches

- On the urban side, providing technical and financial support to urban utilities and local governments, including efficient financial flows and tariff-setting arrangements to encourage expansion, efficiency and sustainability, and on the rural side, supporting the General Authority for Rural Water and Sanitation Projects (GARWSP) as well as the water user associations and communities with regards to operations and maintenance as well as water stewardship at local level

- Working with alternative service providers such as nongovernmental organizations (NGOs) and private sector tankers to ensure greater reach (including the role of tankers for the transfer of bulk water), while ensuring safer quality, fair pricing, and sustainable use of resources

- Consideration of the impact on and interlinkages with child and maternal health and nutrition, especially in light of the food security crisis, when developing interventions

- Learning lessons from past interventions by not repeating failed approaches but rather testing new and innovative ones for example in those areas which have repeatedly remained unserved, while replicating and scaling-up successes where possible

- Coordinating more efficiently among donors

Message 1: The Republic of Yemen is one of the most water scarce countries in the world. The high proportion of water resources used in agriculture (more than 90 percent) and the consequent overdraft of nonrenewable groundwater resources have led to deterioration of both quantity and quality of the resource and to shortage of water for urban and rural domestic supply.

One of the biggest challenges for the Republic of Yemen is to develop and secure sufficient and sustainable water resources to meet the mounting water demands caused by continual high population growth rates and the demand for economic development, mainly in the agriculture sector. With such high population growth, the annual per capita renewable water resource has declined from 221 cubic meters in 1992 to only 80 cubic meters in 2014, and is a scant 1.3 percent of the global per capita average (5,925 cubic meters) and just 14 percent of the Middle East and North Africa region per capita average (554 cubic meters) (World Bank 2016). As a result, several major towns are essentially running out of water: Ta'iz experiences extreme water stress; Sana'a is closing on average, six existing wells each year, and expansion is constrained by lack of new sustainable sources; and, Ibb and Mahweet are suffering growing constraints (Ward 2015). In addition, the coastal cities, including Aden, an economic and commercial hub, lack safe drinking water mainly due to sea water intrusion and deterioration of water quality.

The situation, particularly in towns, has grown more complicated during the conflict since private supply, which was already meeting about half of the Republic of Yemen's urban demand, has expanded to fill the gap left by the inability of the public utilities to deliver. The previous levels of informal rural to urban water transfers (that is, sales from agricultural wells to private networks and the tanker trade) have apparently grown considerably. What limited regulatory control over groundwater abstractions and private water provision government exercised before the conflict has weakened further.

The underlying problems include the following:

- The Republic of Yemen is an arid to semi-arid country with very high water scarcity and population growth especially in the urban centers.

- Water has been appropriated everywhere largely for agricultural use through traditional irrigation methods, given the subsidies (diesel, pumps, digging of wells) provided by government to the farmers at specific point of time.

- Lack of water resources governance and regulation has meant that there is no enforceable system to allocate water resources to urban use or to protect these resources from infringement by other users

Agriculture uses about 90 percent of the Republic of Yemen's scare water resources (MWE 2008), a significant portion of which is being used for qat cultivation. As shown in the report, the entities who are supposed to regulate resources or behave as stewards are not fulfilling this role—often because of lack of capacity and resources, ability to enforce, or lack of political will. Further, the increasing emergence of new actors—especially during the conflict—such as private water tanker distributors and, to some extent, NGOs to fulfill the service delivery gap can make sustainable management more complicated: the added profit motive in the absence of strong regulatory mechanisms can make water use unsustainable and unsafe.

Although this pre-conflict WASH diagnostic does not delve into the topic of water resources management (WRM), given the importance of WRM for the Republic of Yemen and the increasingly inextricable link between WASH services and WRM, the report highlights the need of tackling the challenging issues related to WRM. The report also recommends further and immediate research into the water-agriculture (and possibly energy) nexus in the Republic of Yemen. The diagnostic highlights that all future interventions, even when considering emergency operations, must keep in mind the sustainable use of water resources: the misuse of water today could lead to more deleterious effects in the near future.

Message 2: New evidence suggests that poverty in the Republic of Yemen has increased over the past decade, even more sharply post-2014, exposing the poor Yemeni population to an even greater livelihood risk. The modest improvements in WASH services between 2005 and 2014 were uneven across space, with persistent gaps between rural urban areas, and are now at a risk of reversal since the country remains in conflict.

According to results from the latest Household Budget Survey (HBS) data, the headcount poverty rate in the Republic of Yemen stands at 48.6 percent of the population in 2014. This is a 13.2 percentage point increase in poverty from 2005, when the comparable estimate of poverty was 35.4 percent. Rural poverty, which has always been higher than urban poverty, the Republic of Yemen has also seen a sharper deterioration between 2005 and 2014. Poverty is heavily concentrated in some governorates, while urban areas such as the capital city of Sana'a are among the least poor areas. *Vulnerability*, defined as the proportion of the population not in poverty but at substantial risk of falling into poverty and measured by those living below two times the poverty line, stood at 93 percent in 2014. This implies significant concentration of households just above the poverty line. One of the key correlates of poverty in the nation is household size: larger households (and family sizes are quite large, generally an average household size of 6.5) are at a higher risk of being in poverty.

Across the Republic of Yemen, preconflict, access to clean water services has improved. However, evidence suggests that urban water supply services are not keeping pace with needs. In addition to the very serious underlying problem with dwindling bulk supplies, which directly impacts bulk water provision, these are the main challenges of the Republic of Yemen's urban water supply subsector:

- Expansion of public networks has not kept up with rapid urbanization.
- Public water supply is often intermittent, sometimes with long intervals.
- Poorer households have less access to—and pay more for—water than better off ones.

Although there have been some gains in rural water supply provision, the difference between urban and rural areas is vast, and the situation is deteriorating.

On sanitation, the data demonstrate clear pre-conflict improvements in access to urban sanitation services, but there are still low levels of network access for sewage disposal and consequently a high dependence on non-flush toilets. The gap in sanitation services between urban and rural areas and among the various wealth quintiles is high, and the overall low level of access to safe sanitation in rural areas and among the poor segments of the population poses significant health and environmental risks.

Message 3: Poor access to WASH services in the Republic of Yemen is not only worsening human well-being today but it is also depressing the human potential for a large fraction of Yemeni children by pushing them into malnutrition.

The Diagnostic analysis shows a strong correlation between various WASH services and chronic malnutrition among children in the Republic of Yemen. Given available data, we are not able to push the analysis further to come up with a credible causal link between WASH and child nutritional outcomes. But by coupling the basic correlations—including reporting with more in-depth evidence on the relationship between WASH variables and nutrition from other settings—we can speculate that in a country that stands out for poor nutritional outcomes in the Middle East and North Africa region, WASH variables appear to play an important part. Further, the costs of poor childhood nutrition on acquisition of human capital and long-term performance in labor markets are well documented. Thus, the role of WASH in ultimately depressing the human potential for a large fraction of the Yemeni population cannot be understated.

Message 4: Existing local institutions need to be strengthened, monitored, and regulated, and the sector needs to become more financially sustainable.

Improving WSS delivery in urban and rural areas will require a combination of localized community efforts and central or deconcentrated technical and financial support, coupled with inter-basin and cross-sector resource cooperation. The Yemeni water experience demonstrates that the sector—like much of the geography of the country—operates most naturally at a local, decentralized level. The central control, which started to emerge in the 1970s, has not often succeeded, and de facto, citizens have reverted intentionally to traditional, local solutions. However, purely local service delivery has not proved sufficient both technically and financially. With a growing population, growing and increasing competition for water use (especially for qat irrigation), and alarming dwindling of water resources, the increasing demands on water services are usually not met. Therefore, help from central government (which is often donor provided) is a necessity.

The urban water sector faces three related challenges: (a) lack of bulk water and dwindling of existing sources; (b) utilities that are struggling to expand access and to maintain adequate service standards and financial viability; and (c) private supply, which is efficient but inherently of high cost and questionable quality, unregulated, and with limited economies of scale. These problems have grown worse during the crisis. The challenges therefore require solving the bulk water problem; helping the utilities get back on their feet by completing the necessary institutional development, capacity building, and investment; and forging economically efficient partnerships with the private sector within an agreed regulatory and water resources sustainability framework.

Even when utilities face serious problems of water availability and cost, they can make improvements. Local water corporations (LCs) are working from a foundation, and have been making improvements. LCs have started to introduce new management systems, information technology and geographic information systems (GIS). Management and staff quality is key and is currently highly variable. Options for improvement could include such incentives as performance bonuses, systematic training, and capacity building. Customer relations, such as through awareness campaigns, can improve social accountability and trust and help with demand management. Post-conflict, new nationwide principles for tariff setting should be agreed, and a separate detailed tariff study for each utility should be conducted.

On the rural side, about half of the population lacks access to safe water. These communities may be dependent on poor quality water from shallow wells or water harvesting, or from unprotected springs and streams, often quite distant and requiring arduous fetching, usually by women. Some regions may be dependent on tanker water. The challenge is thus twofold: (a) to ensure that communities that currently lack access to safe water get support to develop water supply schemes based on sustainable sources; and (b) to protect communities with safe access to water source and to run their schemes efficiently and sustainably. Strengthening existing institutions such as GARWSP, the Social Fund for Development (SFD), and the Public Works Project (PWP) that have matured over the past decades and have proved somewhat flexible and resilient over the conflict is essential both for the emergency period, but also for the medium and longer term implementation. At the start of the recovery period, a major program of technical assistance and capacity building will be essential to improve management and operational capacity; this assistance can build on the German Agency for International Cooperation (GIZ) program pre-conflict.

Message 5: The urgent short-term priority is to reconstruct and rehabilitate water systems and work with service providers at the local level and with the private sector within a strategic framework to help rebuild sustainable approaches for access to safe water.

Key to the post-conflict—or even during conflict—approach will be working with those who can improve service provision quickly. In rural areas this means support to community organizations, whether formal or informal associations or traditional organizations that have managed domestic water supply for centuries. The public agencies that support development of modern schemes for communities will be important agents, as will commercial service providers (for example, supplementary tanker services, organized through United Nations Children's Fund [UNICEF]). The role of tankers transferring bulk water from rural areas, where there is sufficient availability, to urban areas might also be considered.

The situation of IDPs and their access to basic WASH also needs to be considered. Although this Diagnostic does not have access to household level data for IDPs, a Rapid Assessment Report by UNICEF (March 2017) indicates that IDPs are not receiving adequate access to WASH services (for example, only 17 percent of those assessed had access to a hygienic toilet). An additional strain is also placed on host families and communities. Further, although data is currently scant, it is possible that the plight of IDPs may very well place a heavy burden on neighboring countries taking in refugees, especially if those countries themselves are severely water resource- and access delivery-constrained.

Given the extreme water scarcity situation in the Republic of Yemen, it is imperative that all uses of water resources—including by the new and growing actors in the form of the private sector and NGOs, communities, and others, are behaving as real stewards of the very limited water resources. Further, are these limited water resources being managed in a way that can be accessible to the poorer segments of the population? Or, are private tankers charging prices

that are out of reach of the poorer households? Finally, drinking water quality is critical, and the spread of cholera must be managed and contained, including through non-traditional water delivery sources. These questions are explored to some extent in the Diagnostic, but there is a need for a separate and deeper analysis to look into these questions. What is clear is that the institutional framework regulating the use of the Republic of Yemen's vital and limited water resources needs to be urgently and carefully considered so that the value is recognized by all stakeholders, and so that sustainability and access is enhanced for the longer term, and not only the immediate short term.

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Abbreviations

AU	autonomous utilities
AWD	acute watery diarrhea
BMI	body mass index
CDG	Core Donor Group
CFR	case fatality rate
DAS	Damage Assessment Study
DHS	Demographic and Health Survey
DLA	district local authorities
DNA	Damage Needs Assessment
DRA	demand-responsive approach
EU	European Union
GAREWS	General Authority for Rural Electricity and Water Supply
GARWSIP	General Authority for Rural Water and Sanitation Projects
GARWSP	General Authority of Rural Water Supply Projects
GDP	gross domestic product
GIS	geographic information systems
GLA	government local authorities
HBS	Household Budget Survey
IBT	increasing block tariff
IDPs	internally displaced people
LC	local corporations
MAI	Ministry of Agriculture and Irrigation
MoCS	Ministry of Civil Service
MoF	Ministry of Finance
MoLA	Ministry of Local Administration
MoPIC	Ministry of Planning and International Cooperation
MoPWH	Ministry of Public Works and Highway
MPI	Multidimensional Poverty Index
MWE	Ministry of Water and Environment
NGO	nongovernmental organizations
NWRA	National Water Resources Authority
NWSA	National Water and Sanitation Authority
NWSSIP	National Water Sector Strategy and the Investment Program
O&M	operations and maintenance

OPHI	Oxford Policy and Human Development Initiative
PIIS	Performance Indicator Information System
PPP	public-private partnerships
PWP	Public Works Program
R&D	research and development
RWSS	rural water supply and sanitation
RWSSP	Rural Water Supply and Sanitation project
SFD	Social Fund for Development
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Fund
VIP	ventilated improved pit
WEC	Water and Environment Center
WHO	World Health Organization
WRM	water resources management
WSS	water and sanitation service
WSSP	Water Sector Support Project
WUA	water user associations
WUG	water user groups

Chapter 1

Introduction and Context

This report is part of a global set of Water, Sanitation, and Hygiene for All (WASH) diagnostics carried out in countries where WASH services for the poor are deficient and where there might be institutional constraints to improving coverage and services. The Republic of Yemen is an important case because it has an active armed conflict, a plausible increase in poverty over the last decade, and the weakest performance on WASH-related indicators in the region.

Analyzing the situation in the Republic of Yemen is significant yet difficult due to the country's political turmoil since 2011, and, since 2014, the violent and destructive armed conflict. Advances in WASH provision made over the last decade been halted, and the wholesale physical destruction, institutional degradation, and movement of internally displaced people (IDPs) have contributed to an alarming deterioration in WASH services (DAS 2016).

The goal of this report is to develop a better understanding of (a) poverty in the Republic of Yemen; (b) the levels of WASH access and service delivery; and (c) the institutional (and to some extent political and economical) constraints to WASH delivery in the Republic of Yemen, recognizing that this is mostly a preconflict analysis. The report also provides pointers for how WASH strategies and investments may be recalibrated in the postconflict period to assist both short-term recovery and medium-term structured development, and how short- and medium-term strategies may fit into a long-term vision of universal access to safe water and sanitation. These suggestions are given with priority to the poor, and noting the country's extreme water scarcity.

The diagnostic utilizes the Household Budget Survey (HBS) of 2005/06 and 2014, which are nationally representative household surveys (WHO/UNICEF 2014). The HBS data contain information on the household roster, activities, dwelling conditions, health, education, anthropometrics, income, durable goods, and consumption. In addition, the National Health and Demographic Survey 2013 complements HBS datasets and is also used. With regard to the institutional analyses, the diagnostic relies on a largely desk-based analysis to identify core problem areas for further investigation and desk-based mapping of structures and relationships to identify a set of priority problems. It relies on the availability of relevant data and secondary literature. Therefore, this diagnostic generates hypotheses to be further tested and indicates areas for further analysis. Further, given the conflict in the Republic of Yemen, the diagnostic focuses on short-term sector reconstruction efforts than on longer term institutional reform, although the latter is important given the extreme water security situation in the Republic of Yemen, and therefore remains within the report's line of sight.

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Chapter 2

WASH Services and Poverty: Trends, Overlaps, and Synergies

The Republic of Yemen occupies a significant area in the southwestern part of Arabian Peninsula. Saudi Arabia borders the country to the north, Oman to the east, the Arabian Sea and Gulf of Aden to the south, and the Red Sea to the west. It has a 2,200-kilometer coastline: The Gulf of Aden takes up about two-thirds of this, with the reminder bordering the Red Sea. The total geographical area of the Republic of Yemen is about 550,000 square kilometers.

The Republic of Yemen can be grouped into five regions: coastal plains, mountain massif, plateau region, deserts, and the islands of Socotra (map 2.1). The altitude elevation averages around 2,000 meters (6,562 feet), with the highest peak at 3,666 meters (12,028 feet), and the elevation level in the Rub al Khali Desert is below 1,000 meters (3,281 feet). The Indian Ocean, the Red Sea, and the Mediterranean have a great influence on the nation's climate. Like that of the rest of Arabian Peninsula, the Republic of Yemen predominantly experiences a semi-arid to arid climate with two rainy seasons: one during spring (March to May) and the second in summer (July to September). The temperatures range from 27°C to 42°C (80°F to 107.6°F), with the hottest temperatures in the coastal and eastern plains during the summer, with little annual rainfall averaging at around 50 mm. The Highlands region has moderate temperatures during the summer and is cold in the winter with a mean annual rainfall of 800 mm, mostly caused by the tropical monsoons during the summer (ESCWA 2015, 32; Yehya 2005).

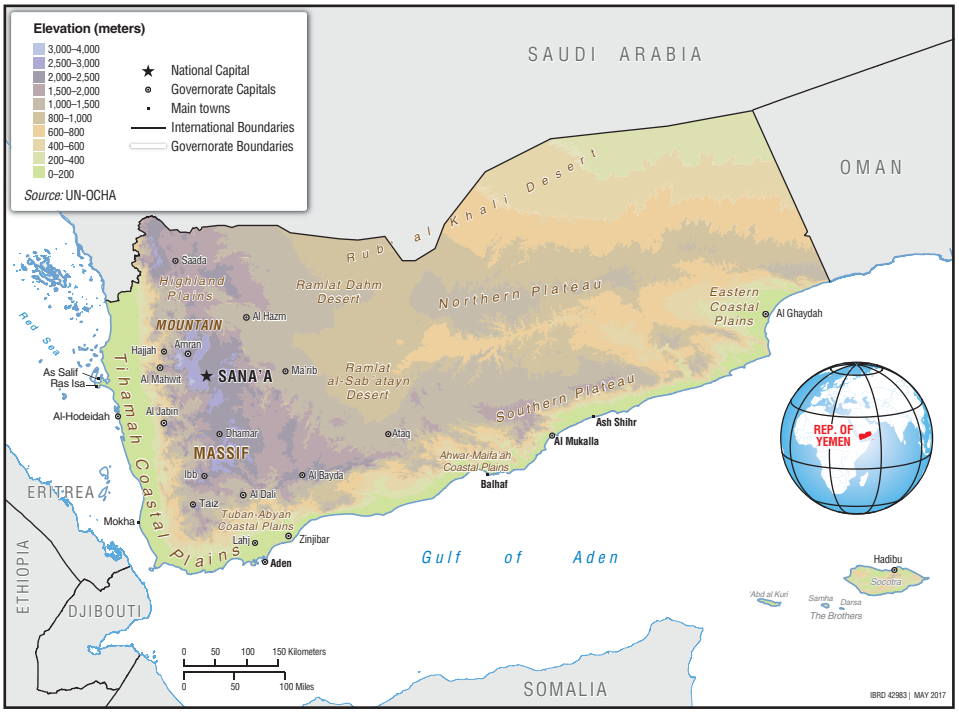
The Republic of Yemen has a population of over 25 million, of which rural residents represent 71 percent and urban, 29 percent. Sana'a is the capital. Aden and Hodeida are the main ports. The eastern part, including Ramlat Alsabatain (Rub al Khali), is mostly uninhabited area but sparsely populated by Bedouin. The western coastal plain is a narrow lowland strip, moderately populated. The central and west highlands are densely populated thanks to the availability of agricultural lands and terraces.

This section profiles the poor, examines access to Water, Sanitation, and Hygiene for All (WASH) services across the population and analyzes the relationship and interaction between access to WASH services and other development indicators. The exploration will be broadly aligned with the following core questions:

- Who are the poor in the Republic of Yemen? What are their characteristics? Where do they live?
- What is the level of access and quality of WASH services and how does it vary across the population, particularly between the poor and nonpoor groups?
- What are the synergies between WASH services and other broader development outcomes?

The data for this part of the analysis come from Household Budget Surveys (HBSs) carried out by the Government of the Republic of Yemen in 2014 and 2005/06 as well as the Demographic and Health Survey (DHS) carried out in 2013. Both rounds of the HBS are nationally representative surveys with modules collecting information on the household roster, activities, dwelling conditions, health, education, income, durable goods, and consumption. While the 2005/06 module of the survey also collected data on child anthropometrics, the 2014 round

Map 2.1: Physiographical Regions, Republic of Yemen



Source: © World Bank. IBRD 42983, May 2017.

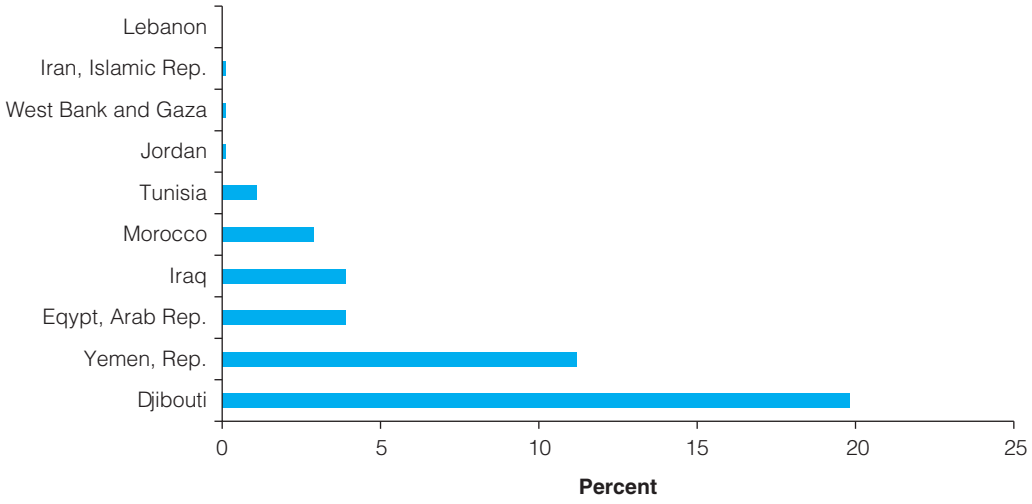
did not collect anthropometric data. As such, this diagnostic relies on the HBS to characterize the nature of poverty and the DHS to explore relationships between WASH indicators and their correlation with other sectors.

Poverty in the Republic of Yemen

Already one of the poorest countries in the Middle East and North Africa region, the Republic of Yemen is likely to have witnessed a significant increase in poverty in recent years. Data from 2012 based on internationally comparable poverty line of US$1.25 show that only Djibouti had a higher rate of poverty than the Republic of Yemen in the region (see figure 2.1). But according to data from the latest HBS, the headcount poverty rate in the Republic of Yemen stands at 48.6 percent of the population in 2014. This is an increase from 2005 when the comparable estimate was 35.4 percent. Owing to the escalation of violence, conflict, and fragility that has severely impacted economic activity, poverty is expected to have increased further, and prehaps more sharply since 2014. Real gross domestic product (GDP) declined by 28 percent and 10 percent in 2015 and 2016, respectively. This will have surely led to widespread deterioration of welfare and living standards in the population; for this analysis, however, the focus will be primarily on the poverty calculated using HBS 2014 data (the latest data available).

Poverty and vulnerability are higher in rural areas. Rural areas also saw a larger percentage point increase in poverty compared to that of urban areas between 2005 and 2014. Rural poverty stood at 59.2 percent in 2014, roughly 17 percentage points higher than the levels

Figure 2.1: Poverty Rates in the Middle East and North Africa, Circa 2012
US$1.25, 2005 PPP



Source: MNA TSD tabulations of MNAPOV data.
Note: Indicators presented are aggregated for circa years. Circa year includes the latest available survey for each country. Welfare aggregates are constructed using country specific methodology. Poverty lines are based in 2005 purchasing power parity (PPP) terms. Poverty rate using US$1.25 poverty line. Updated 08/16/2017.

Table 2.1: Share of Poor, Bottom 40, and Vulnerable, Republic of Yemen, 2005 and 2014
Percent

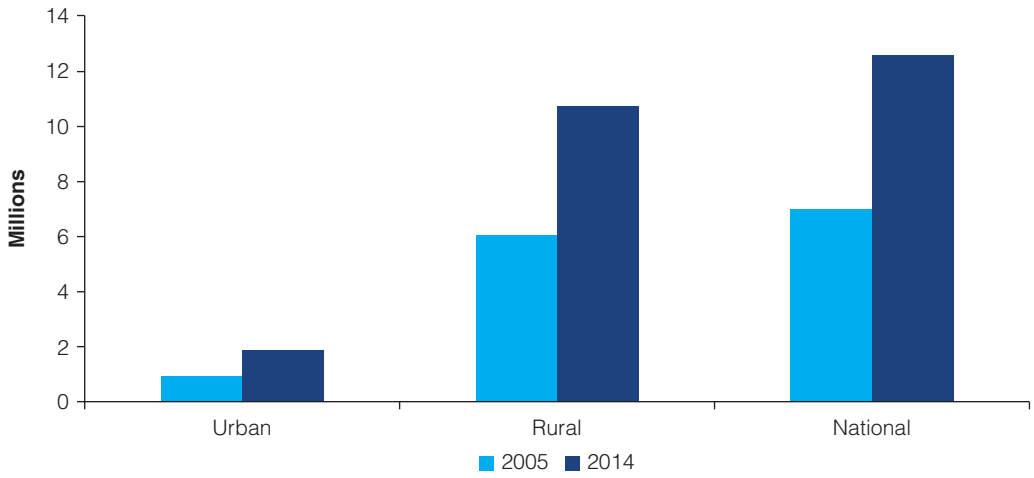
	2005			2014		
	Urban	Rural	Total	Urban	Rural	Total
Poor	17.5	42.1	35.4	23.9	59.2	48.6
Bottom 40	20.8	47.3	40.0	18.0	49.5	40.0
Vulnerable	61.2	88.7	81.2	65.4	93.0	84.7

Source: Poverty Notes for Yemen, 2017 forthcoming.

in 2005. During the same period, urban poverty increased from 17.5 percent to 23.9 percent. *Vulnerability*, defined as the proportion of the population not in poverty but at substantial risk of falling into poverty and measured by those living below two times the poverty line, stood at 93 percent in 2014. This implies significant concentration of households just above the poverty line. Around 18 percent of the urban population fall in the bottom 40 percent of the national consumption distribution in 2014. The share is closer to half for the rural population. There appears to have been very little changes in the urban and rural composition of the bottom 40 between 2005 and 2014 (see table 2.1).

An increase in the poverty rate and the growth in population mean that more households are poorer now. The number of the poor increased from 900,000 to 1.9 million in urban areas between 2005 and 2014. The increase in the poor is more dramatic in rural areas where the poor population increased from 6.1 million to 10.7 million, an increase of more than 4.5 million. Nationally, the number of poor increased from 7.0 million to 12.6 million overall (see figure 2.2).

Figure 2.2: Number of Poor by Location, Republic of Yemen, 2005–14



Source: Poverty Notes for Yemen, 2017 forthcoming.

As expected, there is sizable variation in poverty rates by governorates. Sadaah and Amran are the poorest governorates with poverty rates of 84.5 percent and 75.9 percent, respectively (see Table 2.2). The incidence of poverty is the lowest in Sana'a City, at 13.4 percent of the population. Aden, the second largest city in the country, had a poverty rate of 22.2 percent. The pattern of vulnerability broadly tracks with poverty. Sana'a City and Aden register the lowest vulnerability while the governorates of Saadah, Al-Dhale, Amran, and Laheg have the highest rates of vulnerability. A very high vulnerable percent suggests that the households' total expenditure for consumption is very close to the poverty line.

Poverty is higher among larger households. For this analysis, households are grouped into four mutually exclusive categories: (a) households with less than four members; (b) four to six members; seven to nine members; (d) and more than 10 members. It appears that larger households are more likely to be in poverty while smaller households are less likely to be poor and vulnerable. There is a clear monotonic relationship, as seen in figure 2.3. This is true for 2005 and 2014. Even though smaller households are less likely to be poor, overall poverty has increased for all household sizes. For example, in 2005 only 9.5 percent of households with less than four members were poor. This increased to 23.7 percent in 2014 (see figure 2.3).

As with smaller households, a higher level of education of household head is associated with a lower rate of poverty. Household head education level is divided into four mutually exclusive groups: no education; primary education; secondary education; and higher education. Poverty and vulnerability have increased for all education groups between 2005 and 2014, but there appears to be a monotonic relationship between household head education levels and poverty rates. For example, In 2014, households with household head with no education have 57.5 percent poor. This is in contrast with households with household head with higher education where the poverty rate is 23.6 percent (see figure 2.4).

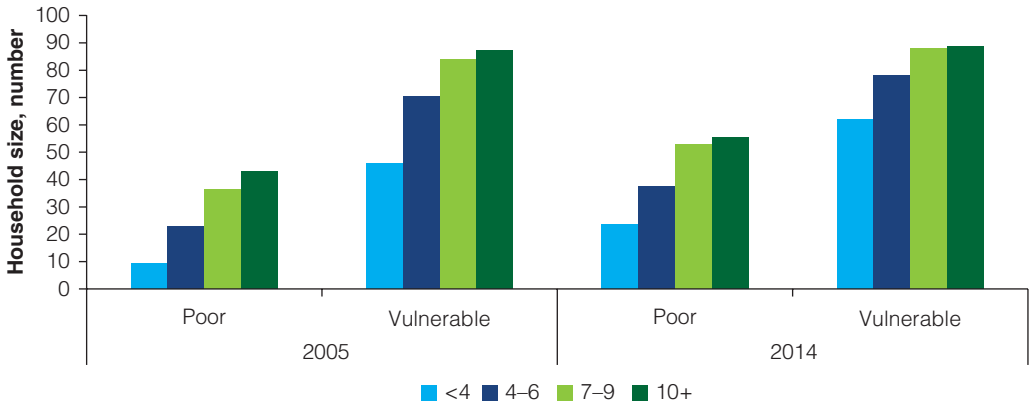
Households with heads holding wage jobs in agriculture have the highest likelihood of being in poverty, followed by self-employment in agriculture (nonwage); nonagricultural wage jobs; and nonwage nonagricultural sector jobs. Over the analyzed period, poverty appears to have increased for all four types of households suggesting a broad deterioration of living standards between 2005 and 2014 (see figure 2.5).

Table 2.2: Share of Poverty Incidence, Yemeni Governorates, 2014
Percent

Governorates	Poor	Vulnerable
Ibb	56.6	91.6
Abyan	48.6	88.2
Sanaa City	13.4	52.0
Al-Baida	39.2	85.9
Taiz	41.4	84.2
Al-Jawf	55.4	92.9
Hajja	63.9	93.5
Al-Hodeida	58.1	87.2
Hadramout	60.6	93.0
Dhamar	31.1	79.6
Shabwah	42.1	84.4
Saadah	84.5	97.9
Sanaa Region	42.1	91.5
Aden	22.2	65.3
Laheg	69.1	95.5
Mareb	25.9	76.2
Al-Mahweet	60.7	94.7
Al-Maharh	57.8	84.5
Amran	75.9	96.2
Al-Dhale	59.8	96.9
Remah	49.5	89.4
Socatra	50.1	86.0

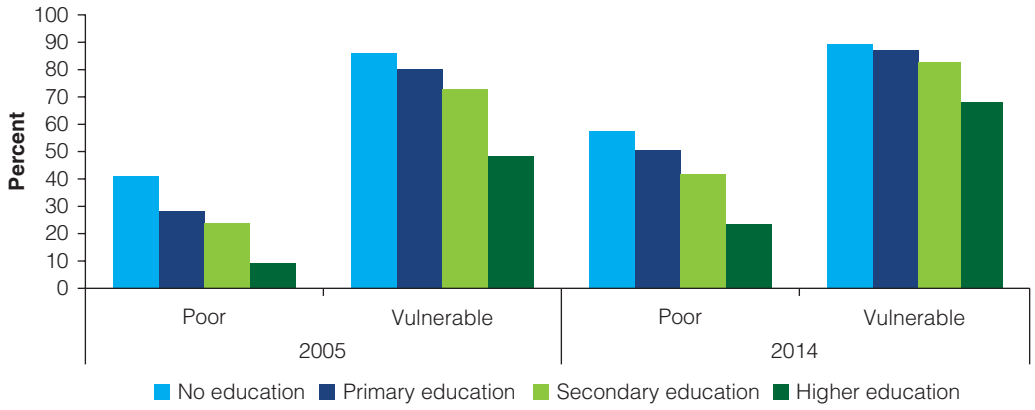
Source: Poverty Notes for Yemen, 2017 forthcoming.

Figure 2.3: Rates of Poverty and Vulnerability, by Household Size, Republic of Yemen, 2005 and 2014



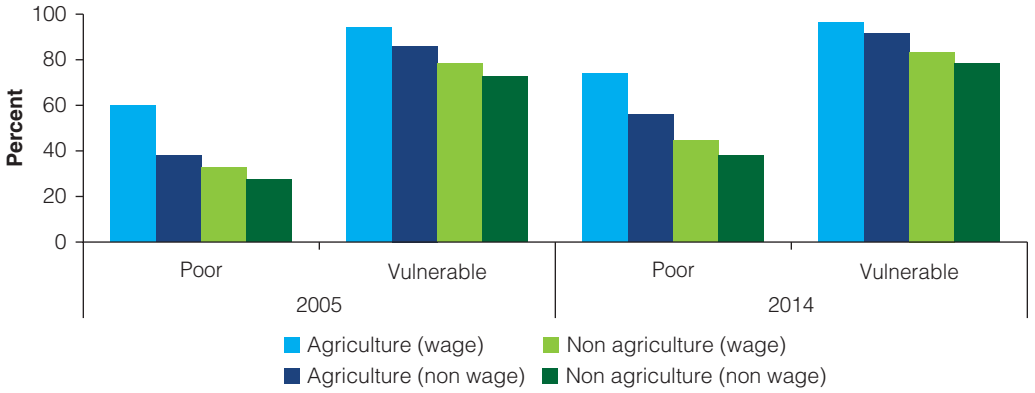
Source: Poverty Notes for Yemen, 2017 forthcoming.

Figure 2.4: Rates of Poverty and Vulnerability, by Household Head Education Level, Republic of Yemen, 2005 and 2014



Source: Poverty Notes for Yemen, 2017 forthcoming.

Figure 2.5: Rates of Poverty and Vulnerability, by Household Head Occupation Type, Republic of Yemen, 2005 and 2014



Source: Poverty Notes for Yemen, 2017 forthcoming.

Access to Water, Sanitation, and Hygiene Services

In keeping with Sustainable Development Goal (SDG)-6, the World Health Organization/United Nations International Children's Emergency Fund Joint Monitoring Programme (WHO/UNICEF JMP) has proposed new indicators to monitor drinking water, sanitation, and hygiene post-2015 by defining access ladders. These drinking water, sanitation and handwashing ladders provide a common framework for monitoring improvements across and within countries. The revised ladders (and the previous ladders for drinking water and sanitation) are in appendix Q. The previous ladders were essentially divided into two simple and mutually exclusive groups for both water and sanitation: "improved" or "unimproved."

Multiple surveys are available to analyze access to water and sanitation in the Republic of Yemen. The Multiple Indicator Cluster Survey, Family Health Survey, and National Census are

all available, though this report focuses on the HBS and DHS. The HBS is the national survey of living standards carried out by the Government of the Republic of Yemen with the World Bank's technical guidance. The advantages of using HBS are that (a) it is possible to compare changes in access to water and sanitation over time since no other survey has two rounds as closely comparable as HBS; and (b) it shows the availability of detailed household consumption data. No other survey affords as great an opportunity to analyze the association between poverty and access to services as the HBS. Data on consumption and expenditure are used to calculate poverty measures.

One of the key weaknesses of using the HBS is that it is difficult to construct access variables with strict adherence to JMP definitions. Thus, the position taken in this report is that wherever it is necessary to construct access rates using exact JMP definitions, the numbers reported are based on data from the 2013 DHS. Otherwise, for a bulk of the analysis of the relationship between access and poverty, the report moves beyond JMP definitions and uses definitions that reflect changing water and sanitation sectors in the Republic of the Republic of Yemen as available in the HBS questionnaire.

This section is organized as follows: each of the subsections on water and sanitation begins with a discussion on JMP trends as published by Progress on Drinking Water and Sanitation and then proceeds to report and analyze access rates using the closest possible JMP definition possible given the questionnaire structure of the JMP. All the analytical outputs will use these latter definitions.

Water

There has been an overall decline in access to improved sources of water. Access to an improved source of water declined from 66 percent to 55 percent between 1990 and 2010. Improved sources of water include piped water into a dwelling; to a yard or plot; from a public tap or standpipe, tube well or bore well, protected dug well, or a protected spring; or rainwater. Unimproved sources of drinking water include unprotected spring and dug well, cart with small drum or tank, tanker water, and surface water. Bottled water is defined either as improved or unimproved. Table 2.3 shows the trends in drinking water coverage from 1990 to 2010.

This decline in access to improved water has worsened throughout the period; it is not due to a single event. In rural areas 47 percent of the population had access to improved source of drinking water. This measure was 72 percent in urban areas. In 1990 more than 96 percent of urban areas had access to improved water (84 percent piped and remaining 12 percent other improved sources). This fell to 72 percent in 2010. Similarly, in rural areas access to improved source of water has declined from 59 percent to 47 percent.

Table 2.3: Share of Drinking Water Coverage Estimates, by Location, Republic of Yemen, 1990–2010
Percent

	Urban		Rural		Total	
	1990	2010	1990	2010	1990	2010
Piped onto premises	84	71	12	26	27	40
Other improved source	12	1	47	21	39	15
Other unimproved	3	27	34	47	28	41
Surface water	1	1	7	6	6	4

Source: WHO/UNICEF 2015.

Nationally there has been an increase in piped water to premises, and the use of "other sources of improved water" has declined. The increase in piped water is due to primarily the growth in piped water into premises in rural areas. Piped water onto premises increased from 12 percent to 26 percent in rural areas between 1990 and 2010. The percent of population covered by piped water has declined in urban areas. The use of an unimproved source of water has increased.

JMP variables for water are constructed using DHS 2013 and HBS 2005–06 and HBS 2014. Box 2.1 shows the how the definitions were constructed.

According to HBS and DHS datasets there is a decline in access to improved water in urban areas and increase in rural areas. These results are consistent with the JMP report. Complete tabulations are given in table 2.4. The numbers on improved water are close to the assumptions made. The small difference in tabulations may be due to the differences in questionnaires between surveys and the difference in timing of the survey.

Box 2.1: JMP Variables Comparison for DHS and HBS: Water

Improved water

- DHS 2013: "Type of water source is piped government network, piped local network, tube well or bore well, rain water, and bottled water"
- HBS 2014/2005–06: "Water supplied is by public water network, private water network, cooperative water network, and if supplied from other sources then artesian well and rooftop water harvest"

Nonimproved water

- DHS 2013: "Well, spring, tanker truck, surface water either protected or not, other, and missing"
- HBS 2014/2005–06: "Non-network and if the source is not artesian well or harvested water"

Source: World Bank definitions.
Note: DHS = Demographic and Health Survey. HBS = Household Budget Survey.

Table 2.4: Share of Improved Drinking Water, Republic of Yemen
Percent

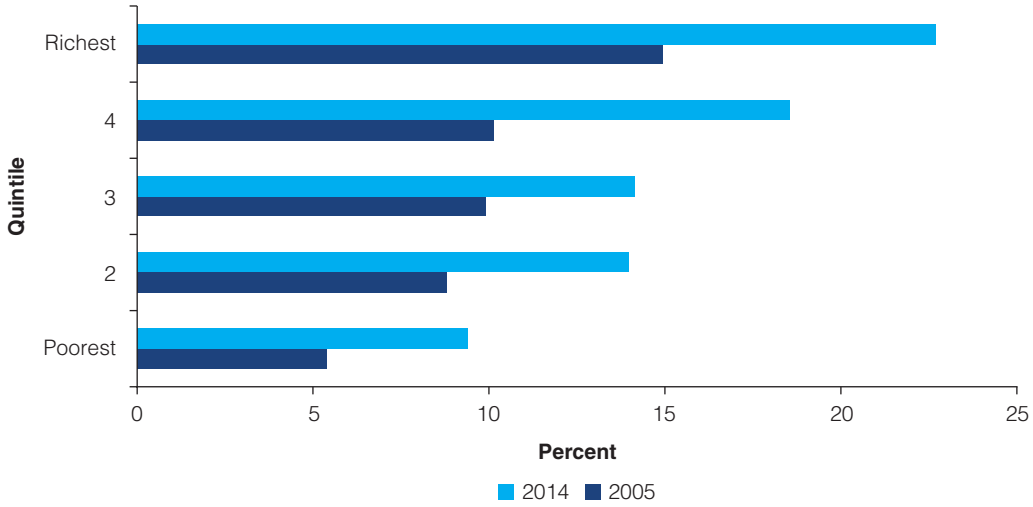
	Urban	Rural	Total
HBS 2005–06	80.0	41.4	52.0
HBS 2014	76.9	48.4	57.0
DHS 2013	78.7	49.7	58.8

Sources: World Bank calculations using HBS 2005 and 2014, and DHS 2013.
Note: WHO/UNICEF Joint Monitoring Programme (JMP) definitions. HBS = Household Budget Survey. DHS = Demographic and Health Survey.

Table 2.5: Share of Water Supply, by Source, Republic of Yemen, 2005 and 2014
Percent

	2005	2014
Network	41.3	47.5
Truck	9.8	15.8
Other	48.9	36.8

Figure 2.6: Share of Water Supplied by Trucks, by Quintile, Republic of Yemen, 2005 and 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

JMP definitions are ideal for analysis since they allow intercountry and across time comparisons. But this report uses other measures common in HBS 2005 and HBS 2014 surveys that track changes in access to water. These selected measures give a better picture to assess the access to water over time since the JMP definitions, which are aggregated by making assumptions, may hide trends idiosyncratic to the Republic of Yemen. Access to water is divided into network, water trucks, and others. Network includes water supplied by public network, private network, and cooperative network. Other sources include when water is not supplied through networks or water trucks.[1]

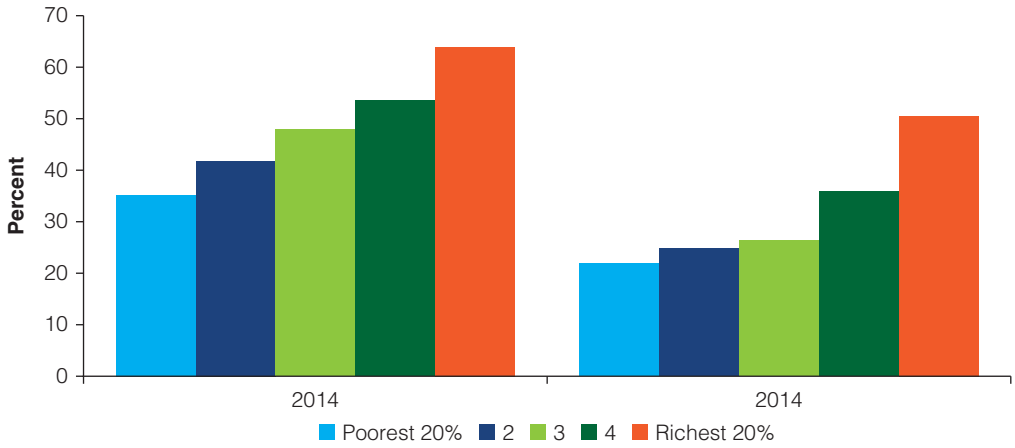
Use of trucks as source of water has increased over time. The latest data show that around 15.8 percent of the households receive their supply of water from trucks. This was 9.8 percent in 2005 (see table 2.5). This increase in overall percent implies more households are relying on trucks than previously. This increase in use of trucks for supply of water is true for all expenditure distribution as shown in figure 2.6. A higher fraction of households from the richer quintile get their water from water trucks, though the financial burden of water supplied from trucks is likely higher for poor households.

Better-off households have better access to water facility. Water from a network, including public networks, is skewed toward the rich and the urban population. The skewed distribution is more marked for public networks where 45 percent of households in quintile 5 have access to public network connections as compared to only 22 percent of households in quintile 1 (see figure 2.7).

Most of the burden on collecting water falls on women and girls and little appears to have changed since 2005 (see table 2.6). As typical around the world, the burden of collecting water falls disproportionately on women in the Republic of Yemen. Around 84 percent of the individuals that collect water are women and girls. In addition, most of the households that collect water from sources other than a network reside in rural areas. It is also noteworthy that the collection burden has not changed much over time. For men, it has decreased somewhat and for female members of the household it has correspondingly increased, though the size of the changes are probably not significant statistically.

Water sufficiency has worsened for richer quintiles (see Figure 2.8). In 2005, higher fractions of households from higher quintiles were more likely to self-evaluate the water supplied as being sufficient. Recently, poorer households are more likely to self-evaluate their supply of water as being sufficient compared to higher quintile households. Since the better-off

Figure 2.7: Share of Water Supplied through Network, by Quintile, Republic of Yemen, 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Table 2.6: Share of Water Collection, by Gender, Republic of Yemen, 2005 and 2014
Percent

	2005	2014
Male	17.4	15.7
Female	82.6	84.3

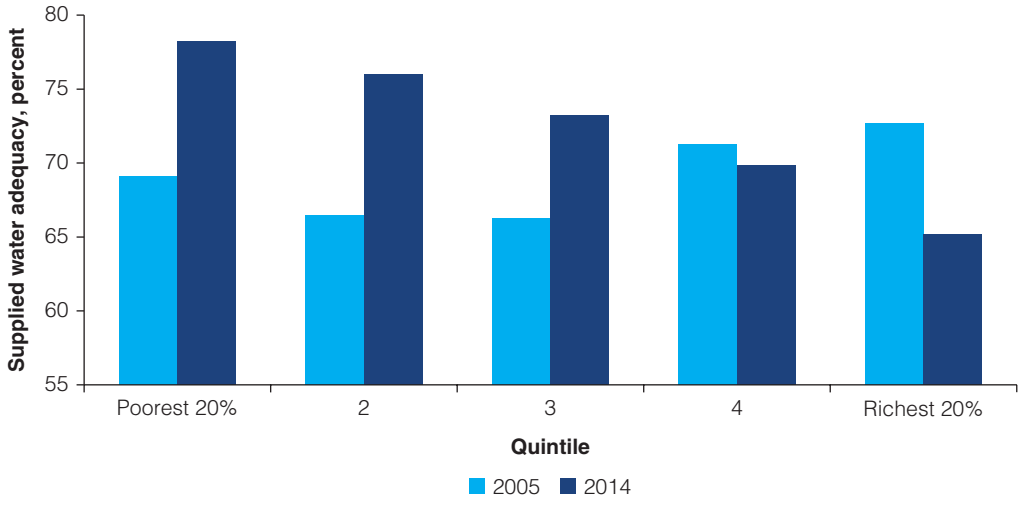
Sources: World Bank calculations using HBS 2005 and 2014.

Table 2.7: Share of Water Collection from Outside, Republic of Yemen, 2005 and 2014
Percent

2005	48.2
2014	36.1

Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Figure 2.8: Adequacy of Water Supplied, by Quintile, Republic of Yemen, 2005 and 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Table 2.8: Share of Urban Water Supply by Networks, Republic of Yemen, 2005 and 2014
Percent

	2005	2014
Network	77.0	74.6
Public network	69.1	69.4

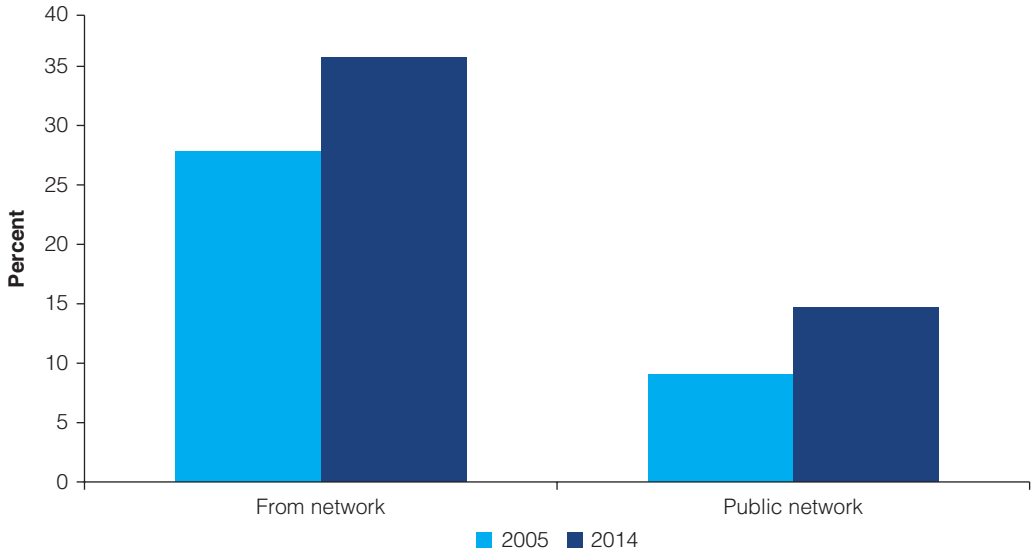
Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

households are more likely to live in urban areas, this self-evaluation of water sufficiency might suggest worsening water sufficiency in urban areas. However, it is also likely that the wealthier households are more discerning about service quality and availability and thus more likely to have a negative reaction to the same level of availability than a similarly serviced poorer household.

As overdrafting of aquifers for agricultural use continues, the vulnerability of potable water supplies is increasing, particularly in the driest governorates. In some areas closer to cities, transfer of water to urban areas is reducing access of rural households (Ward et al. 2007).

Relative access to water from a network is getting worse over time in urban areas due to urbanization, although the absolute number of people with piped services increased. Urban network access has decreased between 2005 and 2014 from 77 percent of the urban population to 74.6 percent, respectively (Figure 2.9). Despite the decline in percentage points, there an increase in absolute numbers of individuals with access to water from a network. In 2005, 4.2 million individuals had access to water from a network; this increased to 5.9 million in 2014. This increase belies an increase in individuals without access to network. Individuals without access to water from network increased by around half a million. Based largely on the table 2.8 and previous work on

Figure 2.9: Share of Source of Water from Network, Republic of Yemen, 2005 and 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

the Republic of Yemen, it is clear that in the decade up to the outbreak of conflict, urban water services failed to keep pace with the rapid expansion of Yemeni towns. Despite heavy investment in network expansion, connections have failed to keep pace with the accelerating pace of rural to urban migration and with consequent urban population growth. Network water services suffer frequent interruptions, with supply intervals of up to several weeks in the worst cases. Several major cities are experiencing drying up of wells and are having great difficulty in sourcing new bulk water supplies. In addition, poorer households have less access and pay more for water than better-off ones. Overall, consumers are experiencing deteriorating quality of services. Some of the points are not obvious from the HBS data, but previous work has shown this to be the case (Ward et al. 2009).

Urban dwellers' perception of access to water services has deteriorated sharply between 2005 and 2014, presumably due to the slow network expansion and growing supply shortages and interruptions (see table 2.9). However, actual ruptures in access have been limited, presumably due to the active tanker market. The percentage of urban households getting their supply of drinking water by water trucks has increased. Though the fraction of households that collect water from other sources is small, households spent a significant time on collection. There has been some reduction in total time spent for individuals over time, but the time per trip has not decreased appreciably (table 2.10).

About three-quarters of rural people say that they have adequate access to potable water, but this is largely from traditional sources. Public network provides water for only 15 percent of the households, with 70 percent of public network use in urban areas. Even though there has been improvement in water supplied from networks, the difference in rural and urban areas is vast. Most rural communities still depend on traditional water supply systems, including wells, springs, or water harvesting. As a result, most rural households still fetch water from distances, which has a disproportionate impact on females. In addition, often water sources are not clean.

Table 2.9: Share of Sufficiency of Urban Water, Republic of Yemen, 2005 and 2014
Percent

2005	73.6
2014	62.8

Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Table 2.10: Urban Water Collection Time, Republic of Yemen, 2005 and 2014

	2005	2014
Time per trip (minutes)	25.2	23.4
Total time (minutes)	76.2	52.6

Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Table 2.11: Share of Rural Sufficiency of Water, Republic of Yemen, 2005 and 2014
Percent

2005	67.6
2014	76.7

Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Table 2.12: Rural Water Collection Time, Republic of Yemen, 2014

Time per trip (minutes)	34.4
Total time (minutes)	99.9
Number of trips	2.9

Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

More than three-quarters of the rural population self-reports that they have sufficient water supply (see table 2.11). In 2005, 67.6 percent of the households in rural areas agreed that the water supply they were getting was sufficient. This has increased to 76.7 percent in 2014. This is consistent with other results that show that water networks have expanded in rural areas.

Two-thirds of rural households that are not connected to a network fetch water from outside. Individuals in these households make an average of three trips daily to fetch water, each averaging more than an hour and a half. There may be more than a single member within the household doing these chores (this is not clear from the survey). This implies that total household time spent on collecting water will be higher than the numbers in table 2.12. A related concern also is that the quality of these secondary sources could be suboptimal: even though some water is available to drink and adequacy numbers are quite high, the hidden health impacts could be large and completely unaccounted.

Sanitation

Fifty-three percent of the population in the Republic of Yemen had access to improved sanitation according to the *Progress on Drinking Water and Sanitation: 2014 Update* (WHO/UNICEF 2014). Survey items representing improved sanitation include flush toilet, piped sewer system, septic tank, flush or pour flush to pit latrine, ventilated improved pit latrine (VIP), pit latrine with slab, and composting toilet. Survey items representing unimproved sanitation include flush or pour flush to elsewhere; pit latrine without slab; bucket, hanging toilet, or hanging latrine; shared sanitation; no facilities; or bush or field.

Unlike the drinking water coverage, which has worsened over time in urban areas, access to improved sanitation has improved in both rural and urban areas. Access to improved sanitation was 34 percent in rural areas and 93 percent in urban areas in 2010. Access to improved facilities has increased in both rural and urban areas over time. Open defecation, which was mostly prevalent in rural areas in 1990 has substantially declined by 2010. In 1990, 44 percent of the rural population practiced open defecation. This declined to 22 percent in 2010 (see table 2.13).

Box 2.2 shows the how the definitions for improved sanitation were constructed.

Access to improved sanitation has increased in both rural and urban areas. These results are consistent with the JMP report. Complete tabulations are given in table 2.14. The numbers on improved sanitation for HBS 2014 and DHS 2013 are not close even though the survey years were close. This may be due to the differences in questionnaires and the difference in timing of the surveys. For example, DHS has information on open defecation but HBS does not. It has information only on the lack of toilet. On sanitation measures the statistics from the two surveys are vastly different. So to make the study consistent between two periods when the HBS survey was undertaken, this report departs from the JMP definitions and uses the household questionnaire that allows tracking access to sanitation over time.

This report delves outside the JMP definitions in trying to understand the access to sanitation. It uses other measures common in both HBS 2005 and 2014 surveys, which track changes in access to sanitation. This report focuses on responses to household ownership of type of toilet and the type of sewage disposal. Types of toilet are divided into four categories: flushed, nonflushed, use of other facility, and no toilet. (Household questionnaires on the type of toilet do not allow us to capture open defecation, since having toilet does not preclude open defecation.) Households are also asked about the type of sewage disposal, which is divided into five categories: public network, covered pit, open pit, nothing, and other.

Table 2.13: Share of Sanitation Coverage, by Location, Republic of Yemen, 1990 and 2010
Percent

	Urban		Rural		Total	
	1990	2010	1990	2010	1990	2010
Improved facilities	70	93	12	34	24	53
Shared facilities	1	2	1	3	1	3
Other unimproved	23	3	33	32	31	22
Open defecation	6	2	54	31	44	22

Source: WHO/UNICEF 2015.

Box 2.2: JMP Variables Comparison for DHS and HBS: Sanitation

Improved sanitation (nonshared)

- DHS 2013: "Type of toilet/latrine is facility Flush/pour to piped sewer system, and flush/pour to septic tank that is non-shared"
- HBS 2014/2005–06: "If the household has all of the following: either has public network or covered pit for sewage disposal, either has flushed or non-flushed toilet, and the toilet is non-shared"

Nonimproved sanitation

- DHS 2013: "Type of toilet/latrine facility is pit, bucket, latrine, other, missing, no facility/bush/field (open defecation) and flush/pour to piped sewer system or septic tank but is shared"
- HBS 2014/2005–06: "All the other types which are not improved"

Source: World Bank definitions.
Note: DHS = Demographic and Health Survey. HBS = Household Budget Survey.

Table 2.14: Share of Improved Sanitation, by Location, Republic of Yemen
Percent

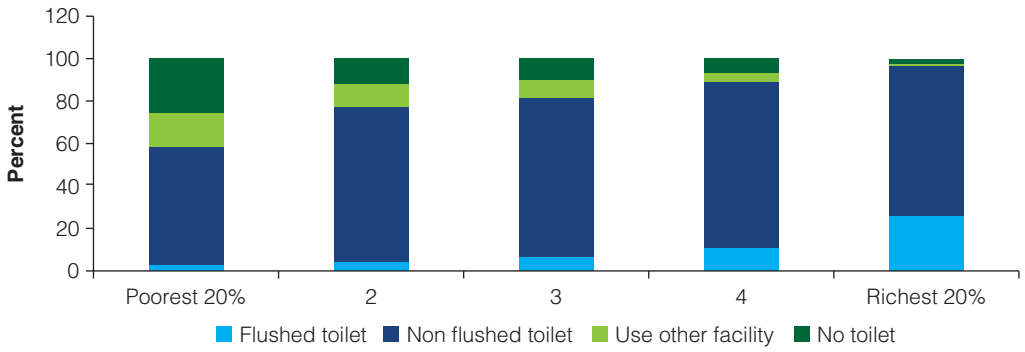
	Urban	Rural	Total
HBS 2005–06	85.65	25.83	42.21
HBS 2014	94.29	40.72	56.88
DHS 2013	83.45	27.21	44.76

Sources: World Bank calculations using HBS 2005 and 2014, and DHS 2013.
Note: Joint Monitoring Programme (JMP) definition. HBS = Household Budget Survey.

Households in the poorest quintile are less likely than other quintiles to have either flush or nonflush toilets. In 2014, 41 percent of the households in the poorest quintile lacked access to either flush or nonflush toilets as compared to only 3 percent for households in the richest quintile. There is a monotonic relationship between use of toilets and quintiles in that richer quintiles have access to either flushed or nonflushed toilets. Over time, use of toilets has increased for all categories (see figure 2.10).

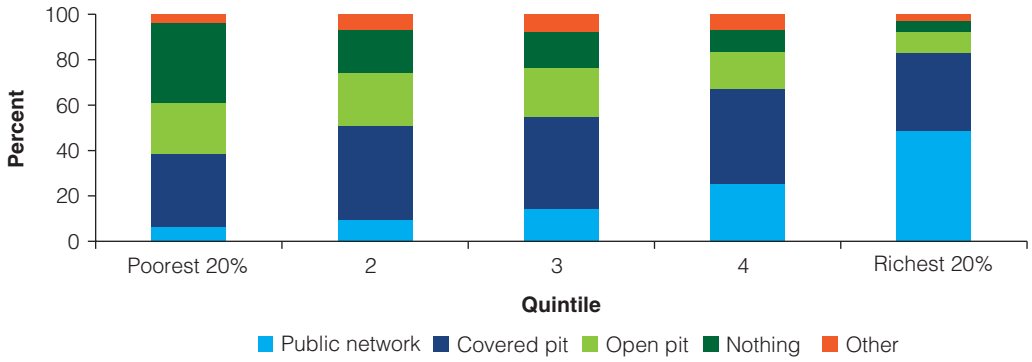
Type of sewage disposal varies by quintile, with higher quintile households having access to better sewage disposal methods. In 2014, 39 percent of the households in the poorest quintile did not have either a public network or pits (closed and open) as compared with 7 percent of the households in richest quintile. The largest difference is seen in access to public sewage network. Fifty percent of the households in the richest quintile had access to a public network compared with only 6 percent of the households in the lowest quintile (see figure 2.11).

Figure 2.10: Shares of Toilet Types, by Quintile, Republic of Yemen, 2014



Source: World Bank calculations using HBS 2014.
Note: HBS = Household Budget Survey.

Figure 2.11: Shares of Sewage Disposal Types, by Quintile, Republic of Yemen, 2014

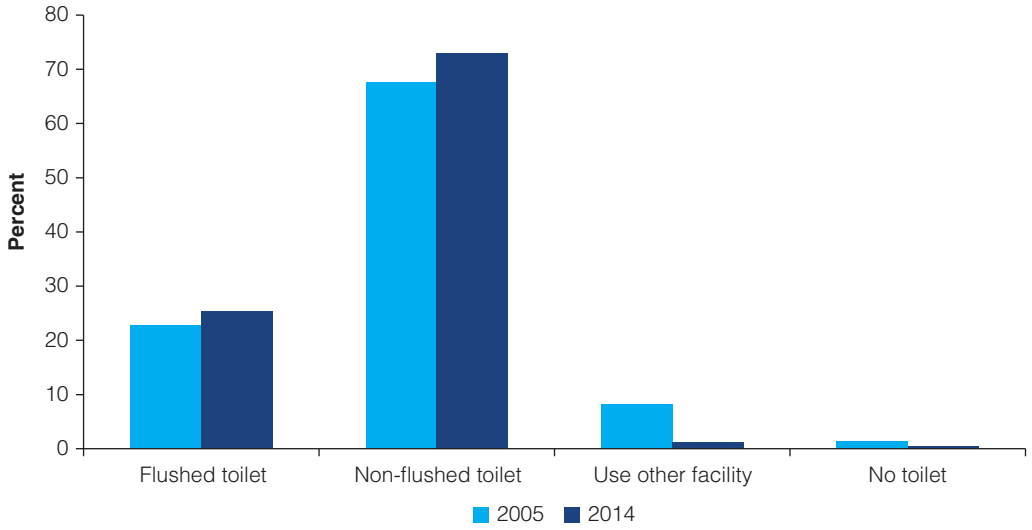


Source: World Bank calculations using HBS 2014.
Note: HBS = Household Budget Survey.

Urban sanitation is largely a matter of individual responsibility and private sector services in contrast to that of urban water supplies. Nationwide, only about one-third of urban households are covered by public sewerage networks, although in some cities, particularly coastal cities such as Aden and Mukalla, more than two-thirds of households are connected to public networks (NWSSIP 2008; Ward 2015, 188).

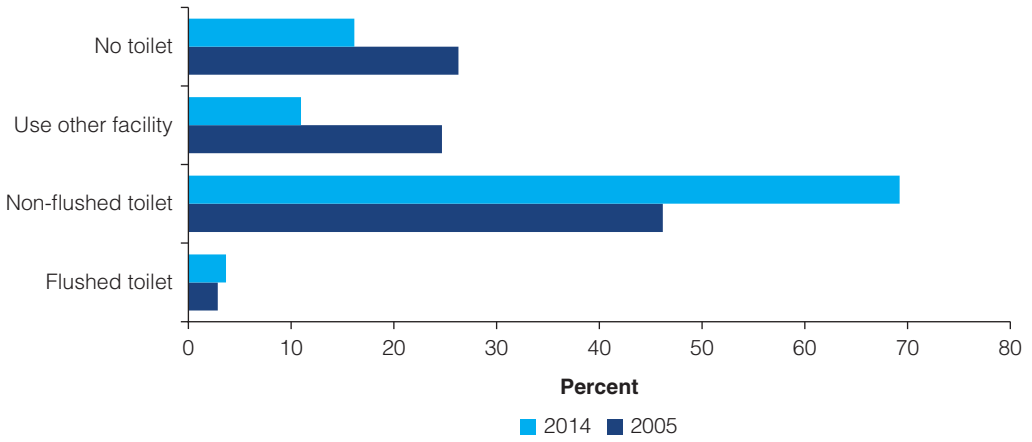
Urban households have invested heavily in toilet facilities: coverage is now almost complete, although two-thirds are nonflush (see figure 2.12). Widespread reliance on cesspits creates environmental and health risks, with seepage of contaminants to groundwater aquifers. Private trucks empty cesspits and generally discharge fecal sludge into public networks by arrangement with the public utility. Nationwide, two-thirds of urban sewage is ultimately discharged into the network. HBS data show that 96 percent of the households in urban areas either dispose sewage into network or into covered pits. This would suggest that sewage is disposed properly, but the recent outbreak of cholera has shown that these numbers may not properly represent the quality of these services.

Figure 2.12: Shares of Toilet Types in Urban Areas, Republic of Yemen, 2005 and 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

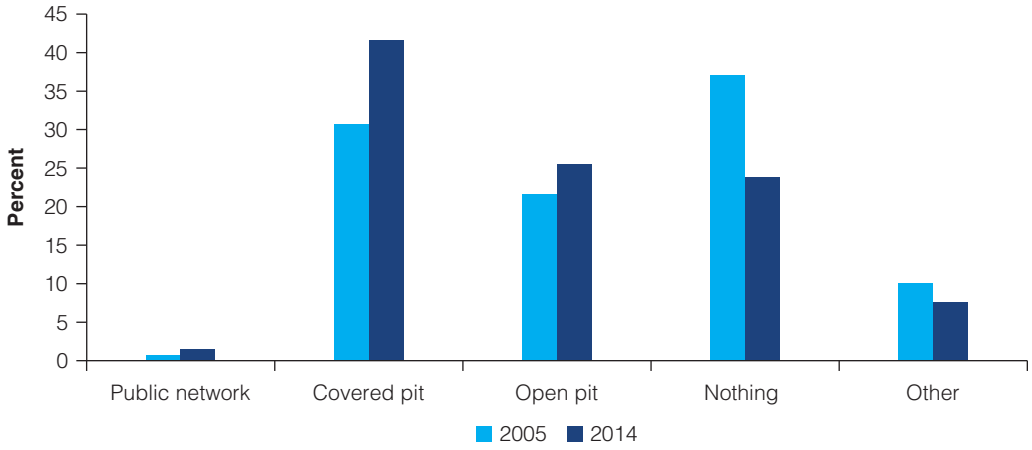
Figure 2.13: Shares of Toilet Types in Rural Areas, Republic of Yemen, 2005 and 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Access to toilet facilities appears to have improved considerably in rural areas. Most of the increase in access to toilet facilities is due to increased use of nonflushed toilet. In 2005, 46 percent of the households had nonflushed toilet. This has increased to 69 percent in 2014. Compared to nonflush toilets, the increase in flush toilet is minimal. Access to flush toilets increased from 3 percent to 4 percent from 2005 to 2014, respectively (see figure 2.13). This increase in nonflushed toilet cannot be fully considered as improvement in "improved" toilet, since not all the nonflushed toilet are connected to proper sewage disposal. Only 43 percent of the households dispose of sewage either in public network or covered pits.

Figure 2.14: Shares of Sewage Types, Rural Areas, Republic of Yemen, 2005 and 2014



Sources: World Bank calculations using HBS 2005 and 2014.
Note: HBS = Household Budget Survey.

Rural areas show a decline in fractions of households that do not have any kind of sewage disposal. Approximately 32 percent of the households in 2014 did not have a public network or pits for sewage disposal. This is a decline from 47 percent in 2005. This decrease is mostly accounted for by a higher use of covered pits. The use of covered pits increased from 31 percent to 42 percent between 2005 and 2014, respectively. Access to public network for sewage disposal is almost nonexistent (less than 2 percent) in rural areas (see figure 2.14). This is in contrast to the urban areas in which 66 percent of households had access to a public network for sewage disposal.

Access to WASH and Child Nutrition

This section deals with the third core question: linkages and synergies between WASH and other sectors. The true underlying causal relationship between the state of poverty and access to WASH services could go either way. That is, the state of being poor could cause low WASH access, or it could be that the poor access to WASH services keeps households and individuals in poverty. With the data available for the Republic of Yemen currently, disentangling this direction of causality credibly is simply not feasible. Instead, this analysis assesses the degrees of association between WASH services and an important measure of welfare in poor countries: child malnutrition.

The report uses the 2013 round of the Republic of Yemen DHS. As with other standard DHS surveys, this survey contains data on child malnutrition as well as its correlates. In addition, as a representative sample survey, it provides estimates for the country, urban and rural areas, governorates, and the capital, Sana'a (MOPHP et al. 2013). The survey provides information on chronic illness, disability, marriage, fertility and fertility preferences, knowledge and use of family planning methods, child feeding practices, nutritional status of women and children, maternal and childhood mortality, awareness and attitudes regarding HIV/AIDS, female genital mutilation, and domestic violence (MOPHP et al. 2015).

Child nutrition is as an important measure of well-being in poor countries. Child nutrition affects schooling outcomes (Alderman et al. 2006; Glewwe et al. 2001; Maccini and

Yang 2009), health (Victoria et al. 2008), and long-term human capital accumulation (Victoria et al. 2008). The UNICEF conceptual framework identifies multiple and multisectoral causes of undernutrition with poor water and sanitation being one of the components. As for the general relation between sanitation and health outcomes, Duflo et al. (2015) find 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. Prior literature linking sanitation and health outcomes suggests that exposure to a polluted environment is one potential determinant of health at birth (Currie 2011). Improved sanitation services are also associated with lower child and infant mortality (Cutler and Miller 2005; Geruso and Spears 2015; Watson 2005). Even for the same level of exposure, there could be important heterogeneities of impact. For example, Currie (2011) finds that children born to less educated and minority mothers are more likely to be exposed to pollution in utero.

Water and sanitation variables punch above their weight in multidimensional measures of poverty, such as the Multidimensional Poverty Index (MPI). Before embarking on the analysis of child malnutrition, a simple assessment of the relationship between access to WASH and the measure of multidimensional poverty in the Republic of Yemen is given in table 2.15. The table presents three different methods of calculating the MPI: the United Nations Development Programme (UNDP) method; the Oxford Policy and Human Development Initiative (OPHI); and a third, which is a slight modification of the UNDP method, specifically for this report. Since WASH variables are often already incorporated in typical measures of MPI, the recalculated MPI allows backing out the contribution of the deprivations in WASH-related variables to the overall MPI. For this purpose, MPI calculation already carried out by the UNDP using the DHS data is used as the starting point. Since WASH variables are included within the dimension relating to "standard of living" in the standard MPI calculations, the first step is to unpack that and separate out WASH variables. Recomputation of the MPI for 2013 is done with three dimensions: health, education, and standard of living. Standard of living incorporates WASH variables, which are backed out separately. This reconstructed MPI yields overall MPI value, the headcount rate (that is, the proportion of Yemenis who are multidimensionally poor), and deprivation intensities that are very close to UNDP calculations. It also gives the share of contribution that WASH variables make to the overall MPI. This share stands at 16.7 percent. OPHI numbers are closer to 15 percent. Considering that the weight on these variables in the construction of MPIs is just 11 percent, this implies that WASH variables *punch more than their weight* in these calculations.

Table 2.15: Share of MPI and the Contribution of Different Dimensions to the MPI, Republic of Yemen, 2013
Percent

		World Bank	UNDP MPI	OPHI
MPI value		0.20	0.20	0.24
Head count		38.9	40.0	45.9
Intensity of deprivations		49.5	50.1	51.4
Contributions to poverty	**Health**	25.9	32.2	36.8
	Education	31.7	29.5	28.0
	Standard of living	42.4	38.2	35.3
	WASH	16.7	..	14.7

Sources: http://hdr.undp.org/en/composite/MPIchanges, OPHI Country Briefing December 2016 the Republic of Yemen.
Note: There are slight differences in the exact values of some the measures. This could be due to different assumptions made while constructing the MPI measures.

Stunting is often a measure of chronic malnutrition. "Going forward" analysis focuses mainly on the height for age measure and stunting rate: the percentage of children with height for age z-scores below −2. We focus on these measures because, unlike the other weight-based measures of nutrition, they capture an accumulated stock of nutrition. Stunting is often a measure of chronic malnutrition and as such is likely to have a stronger correlation with complementary inputs such as water, sanitation, hygiene, and other measures of physical and environmental health.

The data from the DHS show that 46.5 percent of children below 59 months of age were stunted in the Republic of Yemen (see table 2.16). Of these, 22.9 percent were actually severely stunted, that is, had height-for-age z-scores below −3.[2] These numbers are worse than the average for the Middle East and North Africa region, which averages an 18 percent stunting rate.[3] The mean negative value for height for age suggests that the children in the Republic of Yemen have worse height for age outcomes than the comparison group that the WHO uses.

Women's nutritional status is also poor (MOPHP et al. 2013). One-quarter of Yemeni women have a body mass index (BMI) below 18.5, while 24 percent are overweight or obese (BMI greater or equal to 25). The poor nutritional status also is manifested in high rates of anemia among Yemeni women. Seventy-one percent of women have some kind of anemia.

While some progress has been made on reducing stunting rates for children, particularly over the decade between 2003 and 2013 (see figure 2.15), other weight-based measures of malnutrition such as wasting (low weight for height) and underweight (low weight for age) have changed very little over time. The current escalation of conflict is likely to have caused severe deterioration of malnutrition indicators. The United Nations Children's Fund (UNICEF) estimates that 32,000 children face severe malnutrition in addition to 2.2 million children in need of urgent humanitarian assistance to prevent further deterioration in nutritional status (UNICEF 2015).

Stunting rates are higher among children in rural areas (see table 2.17). In rural areas, 51.8 percent of children below five years are stunted. This is higher than in urban areas in which still a high rate of stunting of 33.6 percent is observed. Even though the stunting rate for urban areas is lower than the rural areas these numbers are high. This suggests that children in both rural and urban areas are victims of malnutrition.

There is significant spatial and geographical heterogeneity of malnutrition rates within the Republic of Yemen.[4] Stunting rates vary among the governorates ranging from over 60 percent in some to closer to 20 percent in others. Al Mhrah, Aden, and Abyan have stunting rates below 25 percent; the highest is in Remah at 63 percent. Other governorates with high stunting rates are Al-Jawf, Dhamar, Saadah, and Hajja. In these governorates stunting rates are more than 58 percent.

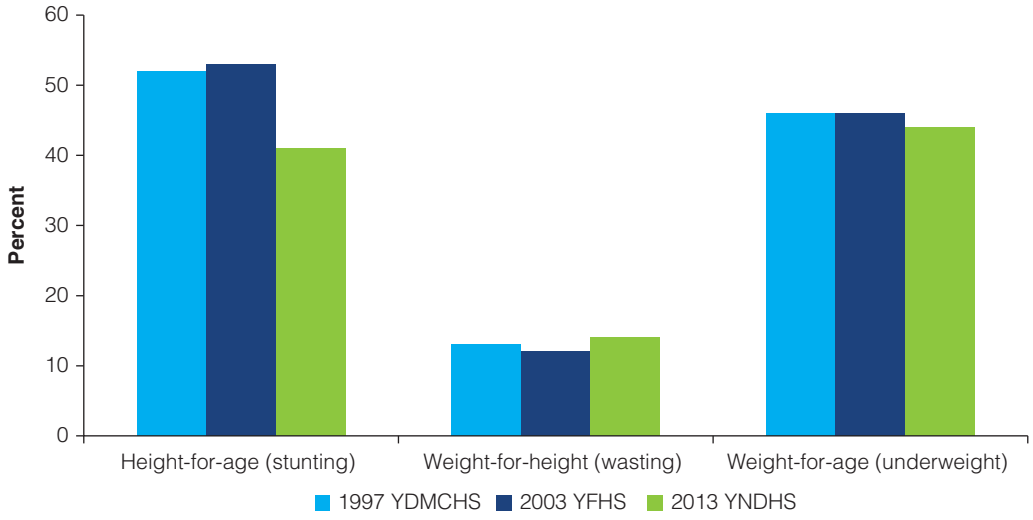
Stunting rates are higher among children in poorer households. The analysis of stunting by wealth quintile shows an unsurprising result. Children growing up in poorer households do significantly worse than children growing up in richer households. In the poorest wealth quintile

Table 2.16: Stunting and Height for Age, Republic of Yemen, 2013

	Child age (months)	
	0–23	0–59
Stunting (%)	0.33	0.46
Height for age (z-score)	−1.31	−1.84

Source: World Bank calculations using DHS 2013 data from the Republic of Yemen.
Note: DHS = Demographic and Health Survey.

Figure 2.15: Trends in Nutritional Status of Children, Republic of Yemen, 1997–2013



Source: Republic of Yemen DHS 2013 final report.
Note: For comparison purpose, the 2013 indices have been recalculated using the 1997 NCHS/CDC/WHO Reference. DHS = Demographic and Health Survey.

Table 2.17: Stunting Rate of Children, by Location, Republic of Yemen, 2013
Percent

Rural	51.8
Urban	33.6

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.18: Stunting Rate, by Wealth Quintile, Republic of Yemen, 2013
Percent

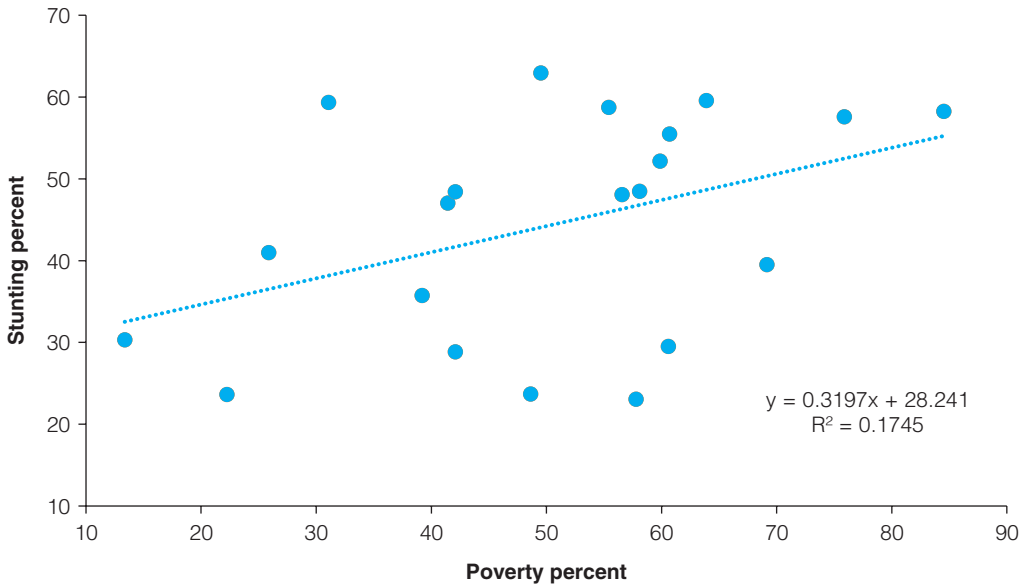
Poorest	59.3
Poorer	55.8
Middle	48.4
Richer	38.2
Richest	26.1

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

59.3 percent of the children are stunted (see table 2.18). This is in contrast to the richest wealth quintile in which only 26.1 percent of the children are stunted. Even though richest wealth quintile children tend to do better than the poorest quintile, the level of stunting even among the richest is still quite high. As the conflict in the Republic of Yemen rages on, the number of children who are malnourished is likely to increase further.

Stunting is positively related to poverty at the governorate level. The variation in stunting appears to be positively correlated with governorate level poverty rates. That is, the poorer governorates also suffer higher malnutrition rates among children. The poverty rates are from

Figure 2.16: Stunting and Poverty, Republic of Yemen, 2013–14



Sources: World Bank calculations using DHS 2013 and HBS 2014 data.
Note: DHS = Demographic and Health Survey. HBS = Household Budget Survey.

the HBS 2014 survey and stunting from the DHS 2013 survey. This correlation of poverty and stunting at the governorate level is represented in the figure 2.16, showing that stunting is negatively related to welfare.

Despite these strong correlations, the economic status of the population alone cannot fully explain stunting incidence. Tabulations of stunting with WASH variables show the link between malnutrition and WASH. The water and sanitation variables are access to improved sanitation, improved community sanitation, basic water, safe disposal of feces, and basic handwash facility. Using the data from the DHS, a household is deemed to have improved sanitation if the household has access to a nonshared toilet facility with pour or flush to piped sewer system or septic tank. A child is regarded to living in an "improved sanitation community" if more than 75 percent of the households in the primary sampling unit in which the child is sampled have improved sanitation. A household is considered to have access to basic water if it has access to improved water in the premises, or if collected from outside the premises, the source is within 30 minutes. If the source of water is public or private network, tube well or bore well, water bottle, and collection of rainwater, then it is considered improved. The household has basic handwashing facility if there is a visible handwashing place with water and soap. A child is regarded to living in an "improved community water" if more than 75 percent of the households in the primary sampling unit in which the child is sampled have improved water.

Access to better water facilities are negatively correlated with stunting. As expected, having access to better water sources is better for child malnutrition. If a child has access to improved water, then the stunting rates are 42.9 percent (see table 2.19). In contrast, 51.7 percent of children are stunted when they do not have access to improved water. Children growing in neighborhood where they have "improved community water" is also negatively correlated to stunting. Along with households' own access to drinking water, access to improved water at the neighborhood level also matters. Access to basic water also has lower stunting rate, as expected, since access to improved water shows lower levels of stunting.

Table 2.19: Share of Access to Drinking Water and Stunting, Republic of Yemen, 2013
Percent

	Yes	No
Improved water	42.9	51.7
Improved community water	40.4	51.9
Access to basic water	42.2	52.1

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.20: Share of Access to Sanitation and Stunting, Republic of Yemen, 2013
Percent

	Yes	No
Improved sanitation	37.8	53.5
Improved community sanitation	30.2	52.2
Safe disposal of feces	44.8	57.3
Basic handwash facility available	41.1	51.2

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.21: Share of Mother's Literacy and Stunting, Republic of Yemen, 2013
Percent

No	54.7
Yes	37.9

Source: World Bank calculations using DHS 2013.

Access to better sanitation facilities are negatively correlated with stunting (see table 2.20). As with access to source of water, access to improved sanitation at the household and community levels shows lower levels of stunting. If the household has improved sanitation, stunting is only 37.8 percent. The stunting rate for children increases to 53.5 percent when the household does not have improved sanitation. Unconditional mean shows that the presence of community sanitation has the lowest level of stunting. Safe disposal of child feces and presence of a basic handwash facility also show lower levels of stunting than in the absence of these.

Mother's education is linked to lower stunting rates. Mother's education is highly correlated with child outcomes. This is also true for children's nutritional outcomes. Around 55 percent of the children are stunted when the mother is not literate (see table 2.21). In contrast, only 37.9 percent of children are stunted when the mother is literate. Defining more categories in education gives a clearer association between mother's education and stunting (see table 2.22). The highest rate of stunting for children (53.9 percent) occurs when the mother has no education. If the mother has education but less than secondary, then the stunting rate is 40 percent, and for mothers who have secondary and above education the stunting rate is 31.5 percent. This stunting rate lies between the top two wealth quintiles stunting rates

Table 2.22: Share of Mother's Education and Stunting, Republic of Yemen, 2013
Percent

No education	53.9
Less than secondary	40.4
Secondary and above	31.5

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.23: Share of Gender and Stunting, Republic of Yemen, 2013
Percent

Female	45.8
Male	47.7

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.24: Share of Birth Order and Stunting, Republic of Yemen, 2013
Percent

1	40.4
2	44.7
3	47.5
4	49.6
5	52.1
6 +	49.5

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

suggesting that mothers' education is a promising avenue to reduce child malnutrition. One caveat is that the education may be closely linked with wealth.

There is not much of a gender gap in stunting rates (see table 2.23). In a number of countries, female children tend to do worse than male children. This is not the case in the Republic of Yemen. Female children tend to do slightly better than male children when measured malnutrition through stunting. Around 46 percent of female children below the age of 60 months are stunted. In comparison, 47.7 percent of male children are stunted.

Birth order matters for stunting. Birth order effects are well established in the literature. This phenomenon whereby children born earlier tend to do better is documented in developing as well as developed countries. Earlier born children are cared for better through various mechanisms like longer breastfeeding, visit to hospitals, etc. Higher birth order children have better stunting rates than later born children. First-born children have stunting rates of around 40 percent (see Table 2.24). This is in contrast to children whose birth order are six and above in which the stunting rate is closer to 50 percent. The stunting rate between the first- and second-born children is close to 5 percentage points. These rates are not within household differences but aggregated at the national level.

Synergies and Complementarities in the Inputs to Child Nutrition

The UNICEF conceptual framework summarizes the causes of malnutrition into three hierarchical categories: basic causes, underlying causes, and immediate causes.[5] The immediate causes are inadequate dietary intake and diseases, and these are manifestations of underlying causes. The underlying causes are inadequate food security, inadequate care and feeding practices, unhealthy household environment, and inadequate health services. The basic causes of malnutrition are around the structure and processes of societies. These include the social, cultural, economic, and political context and the lack of capital, economic or otherwise.

A child's nutrition is a function of adequate food security, health, child care, and environment, which includes water and sanitation for child nutrition. Adequacies are defined along four dimensions: care, health, food and environment, or WASH. Inclusion of particular components gives different definitions of adequacies. Multiple definitions of adequacies are created by dropping some components. More components imply stricter conditions to satisfy each adequacy; this leads to low overall adequacies, which affects the regression estimation. On *food*, a child is considered adequate if she satisfies minimum dietary diversity, minimum meal frequency, and a minimum acceptable diet. On *health*, the child is considered adequate if her birth was associated with at least four prenatal and two postnatal checkups for the mother, the birth was assisted by skilled professional and took place in a hospital or clinic, and if the child has had all the age-specific vaccinations. A child is deemed to be under adequate *care* if she was breastfed immediately after birth and was exclusively breastfed for the first six months of life and if the mother is literate, exposed to media, empowered to make her own decisions on matters of money. Finally, adequacy of *environment* pertains to access to basic water, improved sanitation, improved community sanitation, safe disposal of feces, and handwash facility. Detailed definitions of these adequacies are also provided in the appendix H.

Stunting rates are lower when the adequate components of health are satisfied (see table 2.25). Children who had four prenatal care visits, were assisted during birth, and who were born either at the hospital or clinic have lower level of stunting. Among children who had four prenatal care visits, the percentage of children who are stunted is 30.5. When the children did not have these four prenatal visits, the stunting rates are 46.2 percent. This is a huge gap. This gap can also be seen for children who were assisted during birth and who were born either in hospital or clinic. In addition, postnatal checkup also shows lower level of stunting for children. Though there are differences in stunting rate for children who are vaccinated and not, the difference is not as large as some of the other components.

Table 2.25: Share of Adequate Health Components and Stunting, Republic of Yemen, 2013
Percent

	Yes	No
Four prenatal care visits	30.5	46.2
Assisted birth	37.2	54.5
Birth at hospital or clinic	35.4	51.5
Postnatal checkup	32.6	44.1
Age-specific vaccination completed	42.6	49.7

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Adequate care matters for child's nutritional status. Children who have adequate care are less likely to be stunted except for the case of breastfeeding immediately after birth. Currently breastfed children have lower level of stunting than children who are not. Similarly, children of mothers who are exposed to media either through television or otherwise have lower levels of stunting. The difference is the largest for this component (see table 2.26). Stunting rates are 42.9 percent when the mother had exposure to media and 57.6 percent when the mother did not. Mothers who are empowered to make their own decisions on matters of money and who make own health decisions are likely to have children who have lower levels of malnutrition.

Children who satisfy adequate food components have low level of stunting (see table 2.27). Children who get a diverse diet have stunting rates of 25.1 percent compared to 39.5 percent when they do not. Similarly, the stunting rate is only 24.7 percent when children get a minimum acceptable diet. Having frequent and enough meals is also linked with lower of stunting. Also, the lack of these components of adequate food shows significant levels of stunting.

The definitions of the four adequacies are used for adequacies analysis (see appendix H). The cutoffs used to define the adequacies for this particular specification are as follows: a child has adequate food if he satisfies dietary diversity and minimum acceptable diet; adequate health if he had at least four prenatal checkups, birth was assisted by skilled professional, and was born in a hospital or clinic; adequate environment if he has access to basic water and improved sanitation; and adequate health if the mother is literate, exposed to media or empowerment, and if the child was exclusively breastfed for the first six months of life. Others results using different definitions of adequacies are shown in appendix I.

Very few children live in households that underlying causes of malnutrition in the Republic of Yemen. Combining the components to create adequacies shows very few children satisfy these adequacies. Comparing different adequacies show that very few children satisfy health

Table 2.26: Share of Adequate Care Components and Stunting, Republic of Yemen, 2013
Percent

	Yes	No
Currently breastfeeding	44.5	49.6
Breastfed immediately after birth	48.5	44.8
Mother with exposure to media	42.9	57.6
Mother with empowerment	44.0	49.6
Mother with money decision abilities	44.3	48.8

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.27: Share of Adequate Food Components and Stunting, Republic of Yemen, 2013
Percent

	Yes	No
Diet diversity	25.1	39.5
Meal frequency	28.9	52.3
Minimum acceptable diet	24.7	50.9

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

care (see table 2.28). Only 3 percent of children in the sample satisfy adequate health. The highest adequacies are satisfied for environment at 14.3 percent. In addition, when none of the adequacies are satisfied, the stunting rate is the highest. Around 55 percent of the children do not satisfy any of the adequacies and their stunting rate is around 57 percent.

Interaction of multiple adequacies shows that children that satisfy adequacies have significantly lower stunting rates. Tables 2.29 and 2.30 show double and triple interactions of various adequacies. The low rate at which these are satisfied for the sample of children suggests a serious shortcoming in providing children with an opportunity to grow in an environment that would lead to lower levels of malnutrition.

Table 2.28: Share of Adequacies and Stunting, Republic of Yemen, 2013
Percent

	Adequacies	Stunting
Food only	7.8	29.1
Care only	5.4	41.7
Health only	3.0	39.2
Environment only	14.3	40.1

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.29: Share of Interaction of Adequacies and Stunting, Republic of Yemen, 2013
Percent

	Adequacies	Stunting
Food and health only	0.7	23.7
Food and care only	1.8	24.2
Food and environment only	1.9	24.9
Health and care only	0.4	30.5
Health and environment only	3.0	24.9
Care and environment only	2.9	34.3

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Table 2.30: Share of Triple Interaction of Adequacies and Stunting Republic of Yemen, 2013
Percent

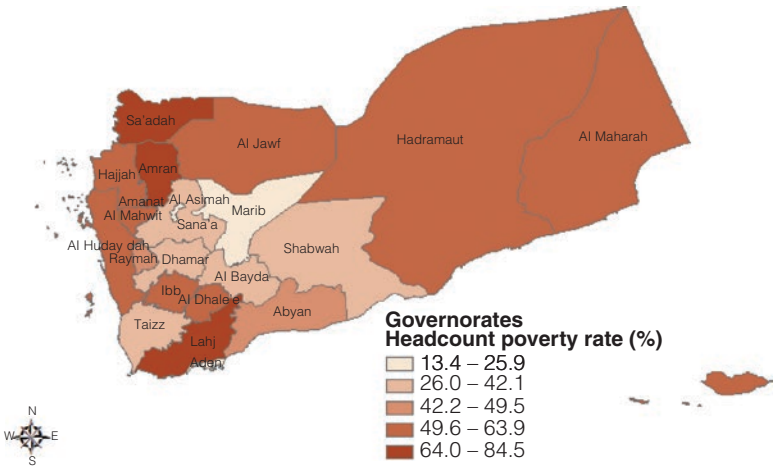
	Adequacies	Stunting
Food, health, and care only	0.4	18.4
Food, health, and environment only	0.7	14.4
Food, care, and environment only	1.0	21.5
Health, care, and environment only	0.6	28.8

Source: World Bank calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Action on malnutrition needs to account for those determinants of malnutrition and the heightened role played by WASH, in particular in emergency situations. Malnutrition is appallingly high in the Republic of Yemen. The recent escalation in conflict has made things worse. The *Yemen Humanitarian Response Situation Report* (Save the Children 2017) notes that 10.3 million children are in need of humanitarian assistance. To reduce malnutrition, the government has to confront not only the underlying causes of malnutrition but also the immediate causes. Making a priority of the immediate causes would help children who are already malnourished as well as targeting new cases of malnutrition due to the ongoing conflict.

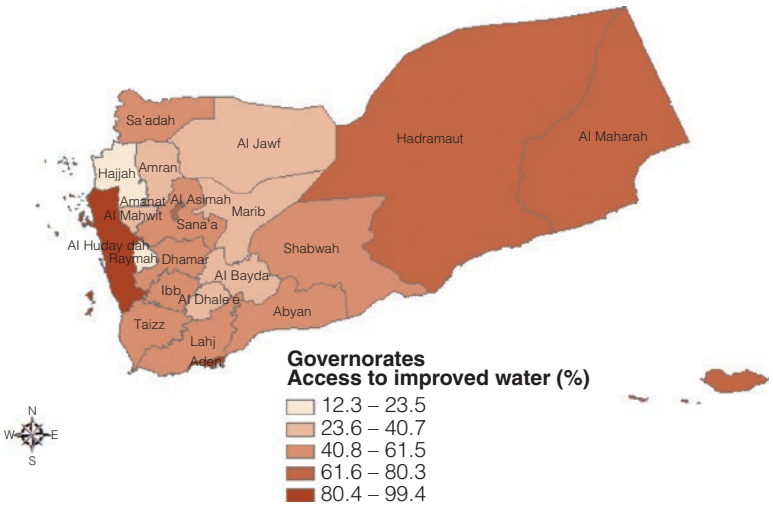
The maps (see maps 2.2, 2.3, and 2.4) below summarize poverty and WASH access in the Republic of Yemen at the time of this study.

Map 2.2: Headcount Poverty Rate, by Governorate, Republic of Yemen, 2014

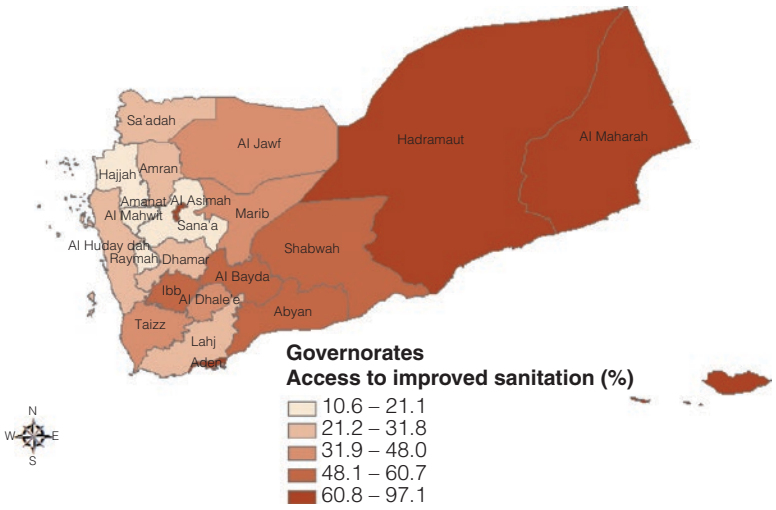


Source: Yemen poverty notes, 2017.
Note: The poverty line is US$1.25 a day in 2005 purchasing power parity [PPP] terms.

Map 2.3: Access to Improved Water, by Governorate, Republic of Yemen, 2014



Map 2.4: Access to Improved Sanitation by Governorates



Source: World Bank staff calculations using DHS 2013.
Note: DHS = Demographic and Health Survey.

Notes

1. The sequence of questioning on water supply is different in the two HBS surveys. HBS 2005 first asks what the main source of water supply is. This is followed by the source of water conditional on the water not being supplied by network. Whereas this is reversed in 2014. First the household is asked about the source of water and, second, how is this supplied. So, to make the definitions of water supplied from network consistent, for 2014, the access to water is defined similar to 2005. Household has access to water from a network if it is supplied by public, private, or cooperative network. As in 2005, water supply sources are conditional on not having water supplied from network or other sources. If the household is not supplied water either by network or water trucks, then the Information on water collection is followed through.
2. Moderate and severe stunting are defined as the percentage of children aged 0-59 months who are below -2 SD and -3 SD from the median height for age of the WHO child growth standards.
3. http://www.worldbank.org/content/dam/Worldbank/document/mna/en/mena_ecd_ch2.pdf.
4. The proportion of children with correct anthropometric data was not uniform across the country—governorates like Hadramout, Shabwah, and Sadah being the most notable ones (MOPHP et al. 2015).
5. http://www.unicef.org/nutrition/training/2.5/4.html.

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Chapter 3

Understanding the Institutional and Organizational Architecture

This section describes the preconflict institutional and organizational arrangements in the water sector. The main aspects that should be highlighted are the following:

- Water and sanitation service (WSS) delivery has been undertaken through a mixture of centralized, deconcentrated, and locally managed or decentralized service delivery. The Ministry of Water and Environment (MWE) is the principal line ministry for WSS delivery. It sets tariff policy, including approving tariff levels charged by urban utilities, and must approve senior appointments to local utility boards. The MWE subsidizes capital and, sometimes, utilities' operating expenditures. Further, the MWE is ultimately responsible for developing rural water supply and sanitation (RWSS) nationwide. Other central ministries are also involved in the water sector. For example, the National Water Resources Authority (NWRA) works with the MWE to organize and develop water resources. The Ministry of Agriculture and Irrigation (MAI) plays a decisive role in water resources management since the percentage of water resources used by agriculture is currently about 90 percent.

- Urban water services are now the legal responsibility of 23 local corporations (LCs) and 10 annexed autonomous utilities (AUs); they provide WSSs in all major towns. Each LC was established by decree and has its own board, which includes central and local government and community representatives. The National Water and Sanitation Authority (NWSA) serves only the 5 percent not yet covered by LCs and AUs through small town branches.

- Several central government authorities are responsible for supporting development of water and sanitation projects for domestic use in rural areas. These authorities are the General Authority of Rural Water Supply Projects (GARWSP), the Social Fund for Development (SFD), the Public Works Project (PWP), and the Ministry of Local Administration (MoLA) through the local council of districts. There are deconcentrated local offices of each of these organizations. Donor funding channeled through the central government has played a large role. Ultimately, rural WSS service delivery is locally managed through traditional and modern institutional setups.

- Local private operators (for example, well owners, private networks, tankers, water purifying shops, bottling plants) have always filled major service delivery gaps. Throughout the current violent crisis, private tankers, and to some extent nongovernmental organizations (NGOs), have played an increasingly important service delivery role; however, private tankers are have unregulated resource management (quality and quantity) and pricing. Although these markets are generally competitive, they are costly and these costs have spiraled during the crisis, resulting in unaffordable costs to the poor.

The remainder of this section provides detailed context and analysis on the institutional and organizational architecture of the water sector, with further details provided in the annex.

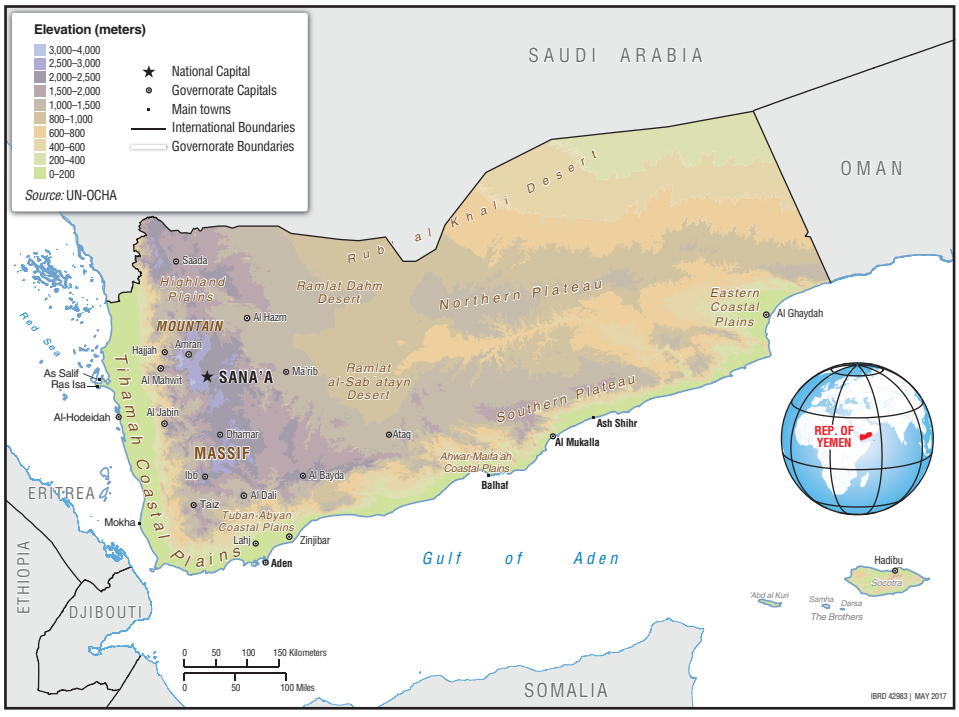
Country Historical and Political Economy Context

The Republic of Yemen has five physiographical regions: (a) coastal plains; (b) mountains; (c) plateau regions; (d) deserts; and (e) the Islands of Socatra (see map 3.1). A water basin is a geographical area that has a common stream, or its water resources constitute one unit that can be subdivided into different water zones to represent a similar water condition. Based on this definition, the NWRA divides the country into 14 water basins (see map 3.2).

Beginning in the 1970s, the modernizing state sought to centralize much of the water service provision through central agencies. Overlaid on this pattern of natural decentralization and local responsibility has been the structure of a modernizing, centralizing state. In 1973, the government established the NWSA to provide urban WSSs in all towns nationwide. In that era the government also invested in turnkey rural water supply schemes through the Ministry of Agriculture, and through a specialized agency, the General Authority for Rural Electricity and Water Supply (GAREWS).

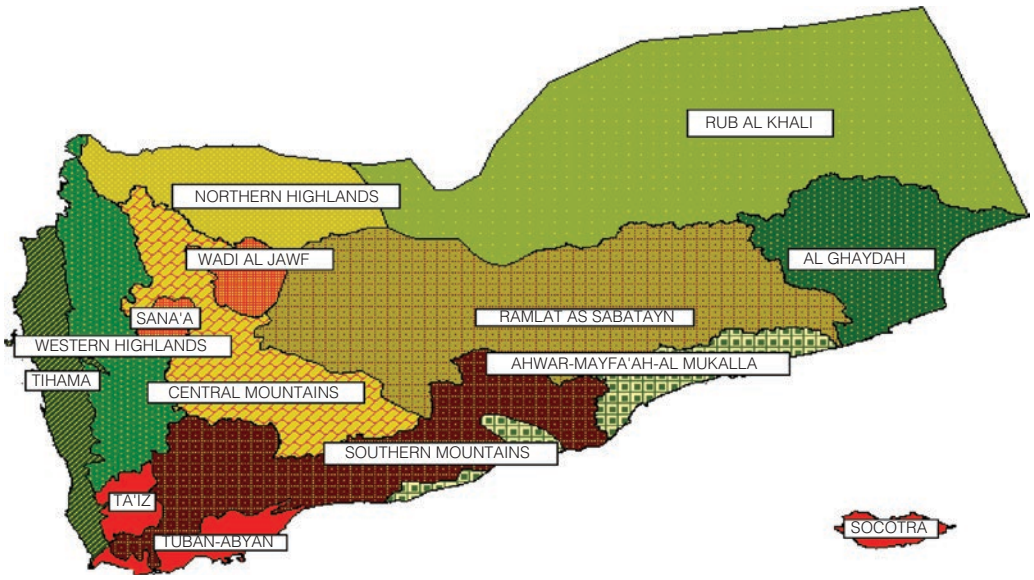
Over the past four decades, the government has invested in substantive development projects. In the highlands and in the coastal plains of Tihama and the southern governorates, investments focused on giant public water schemes such as dams, canals, distribution systems, and dikes. Government programs providing subsidized inputs, including diesel and cheap bank credits, to drill deep wells and purchase pumps for both irrigation and domestic use. One of the oft-cited negative aspects of the government's interventions is that it has benefited the most fortunate individuals, who are well-connected to the government's power base and who have access to land, at the expense of less-fortunate families who may have fragmented lands and scant access to government support (Huntjens 2014; Moor 2011; World Bank 2006a). The government policy to subsidize diesel and drilling deep wells has led

Map 3.1: Physiographical Regions of the Republic of Yemen



Source: ©World Bank. IBRD 42983, May 2017.

Map 3.2: Geographical Regions of the Republic of Yemen



Source: NWRA 2009.

to excessive withdrawal of the fossil-limited groundwater aquifers using traditional irrigation methods. Consequently, several aquifers (mainly alluvial and volcanic aquifers) have been depleted; many wells and natural springs have become dry, especially in the mountainous regions (the annual water level drop is about 5–7 meters) and the coastal soil and aquifers have deteriorated due to seawater intrusion.

After the investments, a large portion of the country's water resources was diverted to agricultural irrigation, now reaching 90 percent of total water use, leaving only 8 percent for domestic use and 2 percent for industrial activities (Moor 2011; World Bank 2016). Irrigated agriculture of cash crops, in particular for qat, has expanded more than three-fold from 39,000 hectares to 174,784 hectares (Al-Ghorbany 2014) Rising incomes and the growth of a market economy with the incentives to groundwater development, combined with an absence of regulation, has led to a proliferation of wells, particularly in the highlands region. This explosion of groundwater extraction has depleted groundwater resources in the main basins of the highlands, including Sanaa, Taiz, Amran, Saadah, and Radaa.

By the 1990s, the centralized approach to urban water and sanitation was experiencing problems. Cabinet Decree 237 of 1997 provides for today's pattern of local urban water supply and sanitation services through decentralized, corporatized, and commercialized LCs. From 2000, public delivery of RWSS projects was also to be deconcentrated and driven by community demand and responsibility.

Governance and Institutional Architecture at the Country Level

Preconflict (pre-2011), the ultimate decision-making bodies in the Republic of Yemen were the Presidency and the Council of Ministers (or Cabinet). Parliament provided area-based representation of the people and debated and passed laws but was largely consultative in practice (see box 3.1).

Box 3.1: Inclusive Service Delivery and Yemeni Governance Structure (Most Sectors)

Institutional Structure

a. Sector ministries
   - Deconcentrated governorate-level branch offices. Limited oversight by Governorate Council Executive Office
   - Deconcentrated district-level branch offices. Limited oversight by District Council Executive Office

b. Downward accountability only through the system of local government[a]
   - Two tiers of local authorities: 21 governorates (government local authorities [GLAs]) and 333 urban and rural districts (district local authorities [DLAs])
   - The capital city, Sana'a, has the status of governorate and its neighborhoods that of

c. GLAs and DLAs
   - Responsibilities of directly elected local council
     - Adopting plans, programs, and investment budgets of the respective administrative unit
     - Overseeing their implementation
     - Assessing performance of local service delivery units ("executive organs") Centrally appointed chief executive: a *governor* (for governorates), or a *general director* (for districts), who are each the chairman of the local councils and the heads of the local administrations[b]

d. Dual accountabilities of executive organs, branches of line ministries, and national agencies (for example, electricity)
   - To local councils through governors and district directors (for the implementation of local plans and budgets)
   - To their respective central agencies (for national sector policies, programs, and projects)

Financing of Service Delivery

a. Central capital fund flow to sector ministries
b. Central recurrent fund flow to sector ministries and national authorities
c. Local recurrent fund flows to GLAs and DLAs.
d. Local capital fund flows to DLAs

Key Issues in Service Delivery: Access, Quality, Accountability, and Capacity

a. Design issues: lack of political autonomy
b. Constrained fiscal environment with 95 percent of all intergovernmental transfers earmarked for recurrent expenditure

box continues next page

Box 3.1: continued

c. Capacity issues: severe shortages in human resource capacity allow representatives of central-level ministries to control the formulation of local budgets

d. Interference by tribal sheiks in local councils (tribal capture): tribal leaders enjoy a disproportionate level of influence in the running of local councils because the administrative lines coincide with their spheres of influence and they dominate the election committees set up to nominate local council members

e. Lack of elections: the failure to hold local council elections since 2006 has seriously undermined the role of local authorities

Source: the Republic of Yemen Policy Note Outline—Menon, August 2016, draft.
a. The current Yemeni Constitution does not mention local governments; instead, the country is divided into subnational administrative units (governorates and districts) that are distinct legal entities within the public sector. The legal foundation of the local authorities system is provided by the Local Authority Law (Law 4/2000), its executive regulations (Decree 269/2000), and its financial regulations (Decree 24/2001). These texts were later supplemented by Law No 18/2008, which provides for indirect election of regional governors.
b. Since May 2008, regional governors (but not district directors) are meant to be indirectly elected by a college of district and governorate councilors in their respective governorates. There have been many years in which governors were appointed rather than elected.

The structure of water sector institutions consists of two national-level ministries (MWE and MAI) and an intermediate-level water authority (NWRA). According to the amended water law and its by-law, the MWE/NWRA are jointly responsible for organizing and developing water resources. The MAI is responsible for formulating policies and legislation that regulate the use of the irrigation water in line with the national water policies and plans and under the umbrella of the National Water Sector Strategy and the Investment Program (NWSSIP). In consultation with the MAI and MoLA, the MWE/NWRA are entitled to update the NWSSIP and form water basins and water zones committees. The NWRA (through its seven branch offices) is authorized to implement water laws and regulation and to allocate surface and groundwater resources to the most compelling needs. De jure, it is empowered to implement strict management tools, including registering and allocating water rights, issuing licenses for water projects, and drilling wells (MAI 2013, 60).

Within the water sector, MWE has been the lead ministry for oversight of water resources and water service provision. By its founding decree (2003), MWE is responsible for implementing policy and developing RWSS nationwide. The NWSSIP sets out the implementation plan for these policies and programs. Local Administration Law 4 (2000) provides for district council responsibility for provision of water supply and sanitation services. The MWE also supervises local water companies (public utilities) and all water suppliers (including private) to the domestic and industrial sectors. Two other ministries have been key to planning and financing the sector: the Ministry of Planning and International Cooperation (MoPIC) is responsible for five-year planning, the investment budget, and donor mobilization and coordination; and the Ministry of Finance (MoF) manages the budget.

The water law authorizes the NWRA to divide the country into water basins and water zones. A basin is a geographical area with a common stream, or its water resources constitute one hydrologic unit. The basin can be subdivided into water zones to represent a similar hydrological condition. The NWRA divides the country into 14 water basins. The NWRA, in coordination with MWE, MAI, and MoLA, has established five basin committees in Sana'a, Taiz, Saada, Turban, and Abyan basins (2008). The basin committees are cross-cutting institutions to coordinate the works of all water authorities pertaining to basins and to implement basin action plans.

All local councils within a basin should have equal representation in the membership of the basin committee. Articles 18–24 of the water by-law lay out the function of the basin committee. The basin committee should help prepare legislation and strategies pertinent to the basin. It should coordinate with NWRA and MAI branch offices when implementing decisions pertaining the basin, and with local councils to manage water resources, resolve water issues, and mobilize local communities and water user associations (WUAs) toward participation in the management of water resources. The implementation agencies at governorate and regional level include branch offices of NWRA, NWSA, GARWSP, and MAI.

Other concerned ministries include the following:

- **Ministry of Health.** Responsible for public health, including setting and supervising drinking water quality standards (although the General Authority for Lands, Survey and Urban Planning is in charge for regulating private drinking water purification stations)

- **General Authority/Department for Awareness and Environmental Health (GAAEH).** Affiliated to the Ministry of Public Works and Highway (MoPWH) and responsible for supervising water quality in urban areas

- **Yemen Authority for Specification, Standards and Quality Control (YASSOC).** Responsible for setting water quality standards

- **MoPIC.** Parent ministry of PWP

- **Ministry of Civil Service (MoCS).** Approves the personnel establishment, organization chart, and salary scales of public entities

Preconflict, local government was assigned largely nominal responsibilities for water supply and sanitation as part of its local development planning mandate. Local government comprised elected local government and council at the governorate and district levels established under the Local Administration Law 4 of 2000. As of 2006, governors were also elected by the councils.

Local governments are supervised by the MoLA and financed by retention of local taxes and by per capita block grants from the center. Local government bodies have been responsible for local development planning, for representing local interests to the center, and for participating in decisions on public investment (for example, district councils in decisions on rural water scheme selection). District councils also provide some financing for rural water schemes.[1]

Increasingly, the private sector has become one of the most important actors in water. Because of the largely fragmented nature of the Republic of Yemen's water resources and the absence of any large perennial streams or rivers, water is largely owned, managed, and used by private individuals, groups or tribes, and communities, and has been for thousands of years. This is in contrast to most countries with perennial rivers and sizable water bodies and in which the state typically asserts ownership or some control.

Private well owners control more than 100,000 private wells across the country, which extract more than 90 percent of the total 3 billion cubic meters pumped out each year. In the absence of any regulatory framework, these private well owners are sovereign in their decisions on water extraction and use. Most use the water for their own farms; some sell to other farmers either by pipes or tanker; some sell or give water to local communities for domestic use; and an increasing number sell water to urban settlements, some by private network, most by sale to the individual tanker trade.

Also very important are the largely uncorporatized, but often "high governance," community institutions that manage water resources and water supplies for community benefit.

Often with a history dating back many centuries, but also including modern local development associations and water service associations, these institutions (that is, with agreed rules and usually elective bodies that implement the rules) manage wells, springs, and water harvesting infrastructure for community domestic water supply, stock watering, and agriculture.

A subset of these community institutions are registered WUAs. Articles 8 and 12–14 of the water by-law provide the legal basis for water users to organize themselves in committees, unions, groups, and associations for the purpose of participating in the management and regulation of water and for operation and maintenance of water facilities. The water user groups (WUGs) and WUAs are registered under the law of Cooperative Societies and Associations. There are an estimated 167 operational WUAs and 640 WUGs (MAI 2013). WUAs or WUGs may be of three types: (a) water management WUAs or WUGs (associations or groups set up usually with NWRA support for water management in a defined area); (b) irrigation WUAs or WUGs (groups of irrigators cooperating on water management and on programs for improved water efficiency promoted by MAI under various projects, particularly the World Bank-supported LWCP and GSCP; and (c) water supply WUAs or WUGs (community associations for managing domestic water facilities in rural areas). Sustainability of these organizations is an issue since WUGs may be active during the implementation of a project and then go into abeyance once the projects are completed. There have been some attempts to help the irrigation WUAs and WUGs to continue working by establishing a mechanism to allow them to obtain bank credit, extension, and marketing services (Steenbergen 2006; Ward et al. 2007).

The modern private sector is represented by the tanker trade: several thousand privately owned tankers that provided, precrisis, about 20 percent of the urban market. This share has reportedly Increased substantially, particularly due to the ongoing armed conflict. Tanker supplies are in rural areas for domestic use and high value agriculture (for example, greenhouse horticulture and open field qat). Private water networks are usually around a former agricultural well. Water purification shops usually sell by the jerry can. These shops are common in towns where water is scarce and poor quality, such as Ta'iz with its very poor network supply and the high levels of nitrates and salt in the water. They are also common in cities like Sana'a, where water is in short supply. Finally several well organized and profitable water bottling companies have nationwide distribution networks (Zabara et al. 2010).

In addition, private sector is represented by wells and tanker trucks that pump and transport water resources for profit. The role of private water tankers has increased substantially, especially during the ongoing armed conflict.

Donors and international NGOs include the World Bank, which has been engaged in the water sector since the 1970s, principally in urban areas, although not exclusively. The Bank initiated the urban water sector reform of 1997. The Bank was also closely involved for two decades in agricultural and irrigation water management through funding several projects. In the 1990s and 2000s, the Bank was very active in sector dialogue, conducting extensive studies across the water sector and promoting NWSSIP and its implementation through funding of the Water Sector Support Project (WSSP). In the 2000s, the Bank took a lead in donor coordination and in the Joint Annual Reviews held for water sector stakeholders (Ward et al. 2007; World Bank 2002, 2005, 2011; NWSSIP 2004, 2008).

KfW and the German Agency for International Cooperation (GIZ) have been major investors in the urban water sector and have supported the Technical Secretariat for Water Sector Reform in MWE and urban water reform since 1997. KfW and GIZ are keenly interested in pro-poor approaches. The Netherlands has been engaged for more than two decades in rural water and has been a strong supporter of GARWSP as lead (or sole) public agency in the sector. It supported the establishment of the Water and Environment Center (WEC) at Sana'a University and funded development of the curriculum for a master's degree in integrated water resources management and the capacity of the academic teaching staff. The Netherlands has also provided occasional support to urban water capacity building (Ward et al. 2007).

Other donors include Japan, which has made equipment donations to GARWSP; Gulf and Arab funds, which have financed urban projects presented by government but have not generally been involved in sector reform or institution building; the United Nations Children's Fund (UNICEF), which has been involved in public health aspects of rural water; and international NGOs (for example, Save the Children and Oxfam). which have been largely involved in piloting approaches and in health education and training.[2] The World Bank recently approved the Emergency Crisis Response Project (US$50 million) implemented by the United Nations Development Programme (UNDP) through (SFD and PWP). This project includes some limited activities in water. Additional financing for this project is under preparation. In addition, a proposed emergency health operation will be implemented by UNDP (World Health Organization [WHO] and UNICEF).

Governance and Institutional Architecture for the Subsector

Urban Water Supply and Sanitation

Before 1997, the municipal water supply in cities and towns across the 22 governorates was managed by the NWSA. The NWSA was a highly centralized management system with many branch offices scattered around the country, but it was hampered by poor infrastructure, intermittent services, unclear rules and regulations, and highly subsidized tariffs (Kalbermatten 1996; Ward et al. 2007). Since the 1997 restructuring, NWSA's operations have steadily shrunk as the new LCs progressively took over. When the crisis started, NWSA branches were serving small towns not yet covered by LCs and AUs, a service area that included about 5 percent of the urban population.

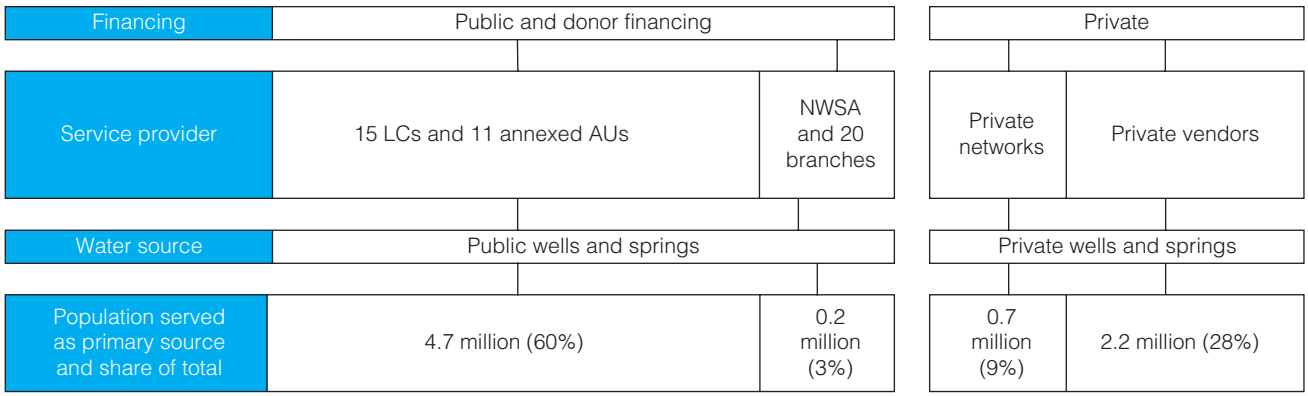
In 1997, the government issued a cabinet resolution based on a technical advice from the World Bank to decentralize the urban water sector (UN ESCWA 2011; Sahooly 2013). Accordingly, the government gradually established public utilities at governorate level called LCs, which by 2011 covered the major capital cities and towns (15 governorates), with 30 branches covering 30 small towns within these 15 governorates (Ward et al. 2009). Urban water services are now the legal responsibility of 23 LCs and 10 annexed AUs, which provide WSSs in all major towns.

Each LC was established by decree and has its own board, which includes central and local government and community representatives. The board is usually chaired by the governorate's governor, who oversees the AUs of LCs. Each LC has the power to hire staff and to impose a tariff, upon approval by the MWE. Before 2011, 95 percent of urban households were within the LC service area, and about half of these households were connected to public water supplies, far fewer to sewer networks. Service was generally intermittent, with 18 of 23 LCs providing daily service, and Ta'iz LC providing water only once every 30–40 days (Ward et al. 2009). Branches of LCs are affiliated to their respective LCs in the governorates, and they receive financial support from the main LCs. Further, the government kept 16 branches of the NWSA to supply water for seven more governorates and towns that have no LCs, which cumulatively cover only 5 percent of the total urban population (Ward et al. 2009).

The NWSSIP (2004, updated 2009) has the following objectives for UWSS:

- Increase access for the entire urban population through investment and by involving the private sector in service provision and outsourcing of functions
- Put utilities on a business footing while keeping services sustainable and affordable
- Ensure affordable access for the poor

Figure 3.1: Schematic for UWSS



Note: AUs = autonomous utilities; LCs = local corporations; NWSA = National Water and Sanitation Authority; UWSS = Urban WASS.

The Technical Secretariat for Urban Water Reform (TS) within MWE was established in 1997 and subsequently supported by GIZ to steer implementation of the urban water and sanitation reform program. The TS has generally been considered to be an effective organization. MWE is responsible for policy and technical standards according to its founding decree (2003), and its Technical Secretariat for Water Sector Reform (MWE/TS) largely assures this function through consultants or donor projects. NWSA retains some residual role in technical assistance, setting standards, training and data collection, and management. However, none of this (e.g., standards and capacity building) applies to private service providers. (See figure 3.1 for a depiction of the urban sanitation sector pre-conflict.)

Most Yemeni towns have urban private network service providers. These typically serve urban households around former farm wells in which urban expansion has encroached on the farm. They are generally efficient and low cost, but they have been neglected by the government and are often crowded out by public supply. There are also some modern network providers that have entered into partnership with the LC.[3] In all Yemeni towns, much of the supply comes from private wells and tankers serving households. Typically, urban or peri-urban wells sell water to tankers, which then deliver the water to urban households. Government officials have generally looked askance at this trade; hence, suppliers keep out of the limelight, even though in some cities, such as Sana'a, they control at least half the market. Nonetheless, studies show their willingness to cooperate with government (Ward et al. 2009; Zabara et al. 2010).

Well owners typically provide standpipes for free water for the poor to collect in jerry cans. In many cities, water supply shops purify bulk water and sell it retail. These competitive businesses usually provide free water in small quantities to passersby and the poor for drinking.

In urban areas, since the level of sewerage connections is low, most houses use cesspits or septic tanks for which suction tankers provide an efficient competitive service to households. The tankers in some towns empty into the public network at designated points against a fee, providing a good example of public-private partnership (Ward et al. 2007, 2009).

Financing Urban Water Supply and Sanitation

According to the NWSSIP of 2005 and 2009, the overriding objective of the water tariff policy is to achieve full cost recovery of water services. The updated NWSSIP (2015) emphasizes increasing accessibility to service water supply in that setting tariffs at "economically efficient"

levels will help in both allocating water resources more efficiently and in achieving financial viability of utilities. The strategy states that the initial target was full cost recovery of operations and maintenance (O&M) costs and half of electromechanical depreciation, moving toward recovery of all electromechanical depreciation within five years.

The MWE is responsible for setting tariff policy for WSSs based on technical, economic, and social analyses as indicated in the Article 3 of the MWE's Regulation Bylaw (218/2004). The decrees for establishing water utilities in the Republic of Yemen stipulates that the utilities should have a "financial autonomy" and should be able to set their own tariffs with a condition to be approved by the MWE (Ward et al. 2009).

Utilities have adopted an increasing block tariff (IBT) in which the household's monthly water use is divided into a number of blocks charging different prices for each block; IBT assumes that the majority of poor people consume less water, and therefore water tariff increases as water use increases. The Republic of Yemen has three to six progressive block rates. The first block is 0–10 cubic meters per month (about 45 liters per capita per day [l/p/c/d]), or the "lifeline rate," which subsidizes low-income households. Table 3.1 illustrates the block tariff applied by Sana'a LC in 2013. Just under half of connections (48 percent) stayed within the lifeline tariff rate of YRI 72 per cubic meters (US$0.23 per cubic meter) at a time when the supply cost was four times that level: YRI 253 per cubic meter, (US$1.02 per cubic meter).

The sanitation charge usually ranges from 70 percent to 80 percent of the water tariff depending on the infrastructure investment and O&M cost of each WSS LC. There is also a monthly connection fee of YRI 500 plus a fee of 5 percent for the local council.

In practice, LCs have had mixed success in adjusting tariffs to achieve target levels of cost recovery. Depending on the quality of water services and the level of utility-customer relationships, some utilities managed to adjust rates more frequently without trouble (for example, Al Shehr in Hadhramout), while others had difficulties persuading their board or MWE to adjust tariffs (for example, Sana'a and Ibb).

As indicated by Ward et al. (2009, 14) that "Some towns have achieved excellent results, others lag behind from a combination of physical, structural and institutional constraints." Some progress occurred through reducing staff through retirement, training staff for professional and technical tasks, and restructuring tariffs under cost recovery principles (al Mahdi 2010).

According to a preconflict Customer Satisfaction Survey, the willingness to pay more than the existing tariff charged by water utilities is quite high although many respondents said that this would depend on whether water utilities have improved the quality of services in water quantity and frequency (Ward et al. 2009). However, the decisions of the boards about water tariffs are still subject to social and political preferences and, in many cases, the boards micromanage decisions (al Mahdi 2010).

Table 3.1: Block Tariffs for Water and Sanitation, Sana'a, Republic of Yemen, 2006

Blocks in cubic meter (m^3)	0–5	6–10	11–20	21–30	> 30	Commercial	Government
Water tariff, YRI	72	72	104	172	208	240	320
Sewage tariff, YRI	58	58	83	138	166	192	256
Connection as % of total[a]	23	25	25%	9	8	11	NA
Water use as % of total[a]	4	12	28	18	10	28	NA

Source: SWSLC 2013, table 6: p. 42.
a. Share of connections based on 2006 data.

Investment costs of network expansion are high and raising connection charges and tariffs to full cost recovery levels has not been considered acceptable. As a result, LCs are perennially dependent on donor finance for investment. Given the high cost of acquiring and developing new sources and of expanding networks, the capital investment required to increase network coverage is high. Developing new sources requires deep wells, especially in the mountainous region, if resources can be located and appropriated. The rugged topography of many cities makes development (and operations) costly. In 2007, the average cost per new household connection was over US$2,000 (Ward 2015, 198). It is assumed that connection charges can recover only a fraction of these costs from the relatively poor consumer base, and that raising tariffs to levels that would recover capital and operating costs and depreciation would be politically unacceptable. Investment and network expansion have therefore been dependent on public grants, usually financed by donors (Ward et al. 2009).

The political turmoil since 2011 has profoundly hampered the momentum to improve the financial sustainable of the LCs. The repeated power outages and diesel shortages have led to increased production costs of water. The widespread refusal in paying water bills and the spike increase in water theft and tampering of water meters reduce revenue collection significantly. See Table 3.2 for an indication of collection efficiency rates. According to GIZ (2016), the collection efficiency between the billed amount and received amount varies among LCs depending on the security and political conditions. For instance, in 2014, the range of efficiency is between 70 percent and 90 percent, excluding abnormal figures. The collection efficiency has deteriorated further in 2015 due to the ongoing armed conflict.

Government subsidies are keeping the urban water sector going. With rising costs, below-cost tariffs, and low collection rates, LCs have been suffering from persistent financial deficits and net cash outflows. As a result, the central government has financially supported eight LCs (out of 16) in 2012 and 2013 to finance their budget deficits for both recurrent and capital expenditures. The size of subsides varies among LCs depending on the size of the network

Table 3.2: Collection Efficiency (Billed Versus Received), Republic of Yemen, 2014 and 2015
Percent

LCs	2014	2015
Tazi-alturbah	124	68
Tazi-City	73	52
Taiz-Mokha	85	85
Amran	90	74
Sanaa City	94	51
Dhamar	84	68
Hodeida-city	73	31
Hodieda-Bait Al-Faqih	83	0
IBB	92	78
Sa'ada	69	76
Abyan	8	0
Hadramout-Mokalla	86	56
Lahij	20	0
Aden	88	0
Hajjah	76	68

Source: GIZ 2016 obtains from various tables.

system and the financial and administrative capacities. Some LCs depend heavily on the central budget for covering operational expenses. The central subsidy for capital investment ranges from a minimum of 7 percent to a maximum of 88 percent of total capital expenditure in 2013. All LCs rely greatly on the central government to finance water projects either from the government's budget or donor agency funds.

Rural Water Supply and Sanitation

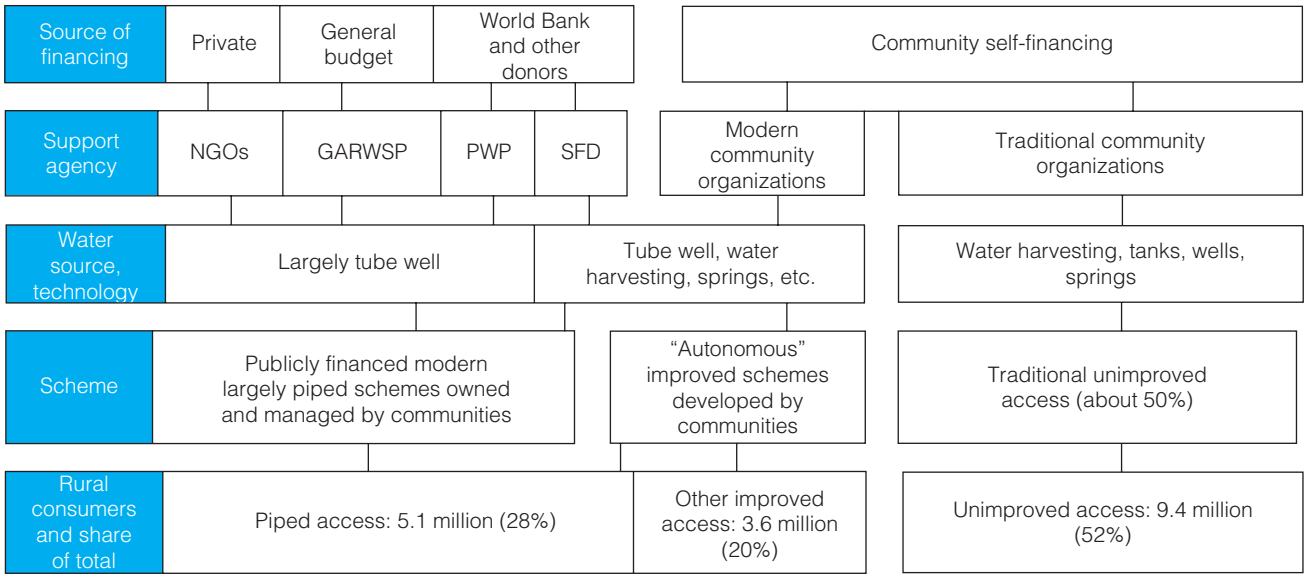
Several government authorities are responsible for supporting RWSS, including constructing water projects for domestic use in rural areas. These authorities are the GARWSP, the SFD, the PWP, and the MoLA through the local district councils. Several donors have also been involved in supporting RWSS, including the World Bank, UNICEF, the Netherlands, Germany, and Japan. Prior to the crisis, GARWSP was supporting about two-thirds of the publicly financed rural water and sanitation schemes and had responsibility for coordinating all public interventions in the sector (Heun and Vulto 2008; JICA 2007; World Bank 2006b).

The GARWSP, SFD, and PWP models support scheme construction and the establishment of community associations to take over operations and maintenances once schemes are constructed. As with RWSS in many countries, the public agencies support establishment of improved water and sanitation schemes but are not responsible for subsequent operations. The public agencies work with communities to check the demand for services, ascertain the availability of water resources, conduct technical and social feasibility studies, select the most appropriate technology, and then subsidize and help implement the agreed investments. A per capita ceiling on the public subsidy is provided, and the partnerships agree on the level of community contribution, usually in kind. The public agencies provide training in operation, management, and accounting. Operation and maintenance are handed over to the communities to be run by a community association, either informally (but following guidelines) or formally (as WUAs). The associations elect committees and appoint staff (typically an operator and an accountant) who are accountable to the association general assembly and are responsible for daily operations and collecting revenues.

GARWSP is the specialized agency for supporting community-managed water supply and sanitation projects. In 2000, as part of a strategy to increase the access of rural residents to clean and sufficient water supplies, the government restructured the former GAREWS[4] into GARWSP under the MWE to focus on developing water schemes for the countryside. The GARWSP organization consists of a headquarter (HQ) in Sana'a with 20 branches in 20 governorates. It has 681 civil service staffmembers, of whom 308 are at HQ while the remaining 373 are in the branches (JICA 2007 and World Bank). Twenty contracted staff are based in HQ and 66 contracted staff are in the branches. Over the past decade, the GARWSP has received a broad range of technical assistance from donors to enhance its functions and to transfer some of its duties from HQ to governorate branches. Under the supervision of GARWSP, hundreds of water projects financed by the government and donors have been executed in coordination with local councils, the PWP, and the SFD (MAI 2013).

PWP and SFD use the same model as GARWSP, except that PWP specializes in labor-intensive projects and SFD supports projects based on other water sources than groundwater. With donor funds, PWP focuses on constructing water projects using local resources, especially labor. To equip water projects with pumps and water pipes, PWP used to coordinate with GARWSP to procure them; currently, PWP assumes the responsibility to install them and then trains local beneficiaries to operate and manage the projects. The SFD follows the same procedures as PWP in community mobilization and in implementing water projects. However, after poor experience with tube well-based projects, in which the water ran out, SFD concluded that groundwater sources are unsustainable in many locations. Therefore, it now restricts its programming to such projects as improving springs and harvesting rainwater. See Figure 3.2 for a schematic depiction of the rural water sector pre-conflict.

Figure 3.2: Schematic for RWSS, Republic of Yemen



Source: HBS 2014.
Note: GARWSP = General Authority of Rural Water Supply Projects; NGOs = nongovernmental organizations; PWP = Public Works Project; RWSS = rural water supply and sanitation; SFD = Social Fund for Development.

Various private and community organizations deliver water services effectively. Some national and regional NGOs and community-based organizations were involved in advocacy and in projects, largely for community mobilization, capacity building, and research and development (R&D). Rural private network service providers managed local area networks, sometimes privately owned, sometimes by delegation from settlements to run community-owned schemes on a commercial basis. These organizations included traditional organizations sometimes centuries old; organizations often set up as "local development associations" in the 1970s; and modern WUAs that are either community initiatives or set up to manage schemes delivered by projects or by GARWSP, SFD, or PWP. The government provided varying levels of support for the community organizations. Some developed into broad-based community development organizations (such as Al-Sina) (Ward et al. 2007; Ward 2015).

Financing Rural Water Supply and Sanitation

All public agencies support development of community schemes on the same basis: a participatory demand-driven model, with cost sharing of investment costs (without capital cost recovery) and with subsequent handover to the community. Once the community has taken over the scheme, it is responsible for management, service delivery, and cost recovery. The community does not pay back any of the capital subsidy. Once complete, the scheme is self-financing in terms of O&M. Communities and their associations responsible for the O&M of a project can and do apply to GARWSP, SFD, or PWP for major replacements, and in principle, there is follow-up training and supervision.

GARWSP is grant-funded, with half of its investment budget coming from donors and the balance from the Government of the Republic of Yemen investment budget. Almost all (95 percent) of GARWSP's operating costs are paid by the government as a grant (table 3.3). More than half of GARWSP's capital budget for investing in schemes—YRI 3.4 billion in 2012 (US$13.6 million), YR 2.1 billion in 2013 (US$9.7 million)—comes from donors, the balance from government funds. See Table 3.4 for information on revenues and expenditures.

Table 3.3: GARWSP Recurrent and Investment Budgets, Republic of Yemen, 2012–13
YRI, millions

		Recurrent budget			Investment budget		
	Total budget	Total	Share of other financing (%)	Share of Government of the Republic of Yemen subsidy (%)	Total	Share of donor financing (%)	GoY budget (%)
2012	4,018.28	615.20	6	94	3,403.08	54	46
2013	3,191.76	768.09	4	96	2,423.68	67	33

Source: MOF 2014: Budget Final Accounts for the year 2013.
Note: GARWSP = General Authority of Rural Water Supply Projects.

Table 3.4: Current Revenue/Expenditure of GARWSP and Central Government Subsidies

		Recurrent revenue			Capital revenue		
	Total revenue	Total	Other-financing (%)	Subsidy (%)	Total	Other-financing (%)	Subsidy (%)
2012	4,018.28	615.20	6	94	3,403.08	54	46
2013	3,191.76	768.09	4	96	2,423.68	67	33

Source: MOF 2014: Budget Final Accounts for the year 2013.
Note: GARWSP = General Authority of Rural Water Supply Projects.

Notes

1. This pattern of partial decentralization would have been modified by the federal structure proposed in the National Dialogue.
2. One international NGO has successfully piloted fog harvesting (SFD).
3. See, for example, the successful partnership arrangement at Ibb described in Ward et al. 2009.
4. Previously GARSWP had broad responsibility for rural electrification as well as water and sanitation but had performed poorly.

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Chapter 4

Diagnostic: Binding Constraints to Service Delivery

This Water, Sanitation, and Hygiene (WASH) Poverty Diagnostic has been undertaken for the most part using information available prior to the ensuing conflict in the Republic of Yemen. Therefore, it is noted that the current and future binding constraints, institutional issues, political economy, and viable options post-conflict may vary greatly from the situation depicted and analysed here. However, many of the arrangements described for the sector still apply—although capacity levels have deteriorated, physical and financial resources have greatly dwindled, and service delivery challenges have severely increased. Lessons can be learned from the pre-conflict arrangements, so that whether developing operations for emergency supply in the short-term, developing service delivery schemes for the medium term, or considering institutional reform for the longer term, the sector can be better informed and prepared to deliver more sustainable services as well as improve the stewardship of the Republic of Yemen's extremely scarce water resources.

The Yemeni water experience overall demonstrates the following: the sector, like much of the geography of the country, operates most naturally at a local, decentralized level. The central control that started to emerge in the 1970s has not often succeeded, and de facto, citizens have often resorted to traditional, local solutions to deal with the emerging challenges and manage their scarce water resources. However, purely local service delivery has also not proved sufficient. With a growing population, growing competition for water use (especially qat) and dwindling water resources, the increasing demands on water services are often not met. And, local capacity—both technically and financially—is often not sufficient. Therefore, help from central government (which is often donor provided) is a necessity. Further, the water scarcity crisis requires the most innovative, increasingly costly, and cross-basin solutions. Working with new actors such as the growing local private sector (tankers) will also be important. What will lead to the actual harmonious balance between local and central control and support for the water sector will ultimately be determined by the shape and conclusion of the on-going conflict.

Below, we analyze the binding constraints for sustainable service delivery along the lines delineated by the WASH diagnostic framework.

Urban Water Supply and Sanitation

The urban water and sanitation sector was progressively restructured beginning in 1997. By the late 1990s, the centralized provision of water and sanitation to the Republic of Yemen's fast growing cities had proved ineffective and a progressive decentralization to local utilities was initiated. The new institutional setup for urban water and sanitation was established by the Cabinet Decree 237 of 1997. The Decree determined today's pattern of local urban water supply and sanitation services through decentralized, corporatized and commercialized local corporations (LCs). The National Water Sector Strategy and Investment Program (NWSSIP 2004) spelled out the action plan for carrying through the reforms, with specific action steps and the required accompanying investment and technical support. The action plan was adjusted and the targets reset in the light of experience in the 2009 NWSSIP Update.

Much of the reform was completed by the start of the crisis but there remained significant constraints to improved service delivery. By the time the crisis began, the initial reforms to establish the LCs were largely complete and a lengthy process of investment and institutional support was well underway to try to deliver the expected benefits. This section delivers an assessment of progress on the reform process up to the start of the crisis and highlights the constraints that have emerged. The section looks in turn at: governance; strategy, planning, and budgeting; financing; human resources; pro-poor orientation; and securing water resources.

Governance

At the start of the crisis, the formal process of establishing new decentralized and autonomous urban service providers under local Boards was almost complete. Cabinet Decree # 237 of 1997 provided for the establishment of LCs to serve the main cities and secondary towns in the same governorate as the main city. By the time the crisis began, 23 LCs had been set up, and their service area covered about 95 percent of the Republic of Yemen's urban population. The powers and responsibilities of LCs and their governance and accountability relationships are set by their statutes, which are established by individual decrees.

De jure, the LC Boards are responsible for all aspects of service development and provision in their area, including design and construction of water supply systems and their subsequent ownership, operation and monitoring. LCs are to implement the design and construction of water supply and sanitation systems, usually through special project units with consultants on donor financing—although this has been noted mainly for Sana'a.

De facto, assessments of LC governance show a mixed picture: almost all capital spending is financed by central government (including with donor funds), so they have a strong say in it. Where there has been genuine accountability of the LC to both the investor (the Ministry of Water and Environment [MWE]) and consumers, investment and supply performance is good—and vice versa. On the other hand, boards have been less effective where supply conditions are difficult and high cost and LCs have not been able to deliver improvements in services. For example, tariff adjustments without service improvements have been held up by local opposition; central government has continued to exercise close control and supervision, weakening the efficiency gains expected from decentralization; financial viability has been limited; and implementation of investment programs has strained utility capability and been constrained by the cumbersome public budget system (Dorsch; Interaction; MWE 2008; Ward et al. 2009).

Good governance of LCs—genuine LC autonomy and accountability—is constrained by the split between asset ownership and corporate governance, by the split between policy and regulation exercised by the center and the local responsibility to run services on a business basis, and by lack of LC financial viability.

- First, the split between asset ownership (by MWE) and corporate governance (vested in the Board) divides and weakens the responsibility of the LC.

- Second, the split between MWE functions of policy and regulation and Board functions of supervision and business planning and execution is ill-defined and has led to too much intervention from the center; not enough supervision and business orientation at Board level; and confused signals and weak incentives at the level of utility management.

- Third, the inability of the utilities to cover their costs and to become self-sufficient financially makes them dependent on central government transfers and investment, and hence subject to central government supervision and control (MACS 2008a, 2008b; Ward 2015, 235 ff; Ward et al. 2009).

Up to now, MWE remains the legal owner of systems it has financed: assets are supposed to be handed over to LC Boards once the LCs are self-sustaining financially. LCs operate and

maintain all assets and set and collect fees from users. LC Boards are responsible for monitoring the functionality and quality of water systems and services. However, MWE monitors the performance of all LCs against benchmarks through the Performance Indicator Information System (PIIS) (Ward et al. 2009; PIIS). LCs, with project support, have developed community outreach and customer relations, but this has been largely limited to handling complaints and has not, for example, extended to involving communities in planning water supply systems. By contrast, the Social Fund for Development (SFD) has practiced community involvement in its urban schemes (for example, small bore sanitation in Ibb), as has the Public Works Program (PWP) (for example, in sanitation in Aden) (Ward et al. 2009).

Further, although the legal framework provides only for public provision of urban water supply and sanitation services, in practice the private sector provides half of these services. De jure, the legal framework is set by Cabinet Decree 237 of 1997, which provides for urban water supply and sanitation service delivery through autonomous LCs which are decentralized, corporatized and commercialized. The powers and responsibilities of LCs and their governance and accountability relationships are set by their statutes, which are established by individual decrees.

De facto, prior to the armed conflict, the private sector provided about half of the Republic of Yemen's urban water supply and much of sanitation services. Through NWSSIP, MWE has set a policy that all LCs should seek opportunities for outsourcing of functions and should develop partnerships with private service providers, especially in towns where public network coverage is limited (Ward 2015; Ward et al. 2009). There is some outsourcing of functions in a few LCs–but only isolated formalized partnership arrangements have been established (for example, Ibb local area network, Sana'a agreement on sludge disposal). Studies have identified the willingness of the private sector to collaborate and a few have proposed transaction models (Zabara et al. 2010). Private suppliers were to be progressively brought within the regulatory, planning and monitoring framework (NWSSIP 2008; Ward 2015, 193–94), but to date much of the private sector's work (for example, tankers) is not formalized, and remains unregulated. Since the start of the armed conflict, the role of the private sector has greatly expanded.

The urban water sector is fragmented, without a clear coordination mechanism. Decentralization and corporatization of water supply and sanitation services initiative, while good in principle, has been less than effective. There is a lack of consistent approach within which every player discharges its responsibilities in the sector as well as how each of these institutions function together to improve coverage and quality of services (MWE, the National Water and Sanitation Authority [NWSA], LCs, PMU-UWSSP, and others). Similarly, much of the investments in the urban water sector do not follow pre-defined guidelines, and coordination among the many players is rare. Further, with the increasing role of private provision including tankers, resource management and affordability for the poorest are increasing concerns.

Strategy, Planning, and Budgeting

The National Water Sector Strategy and Investment Program (NWSSIP 2004, updated in 2009) was good at setting the need to work on water across the sector and beyond. However, the agenda was too ambitious and the planned investment cost was large. The regulation agencies (for water resources and services) were also not empowered, which limited the enforcement. Further, the conflict started on 2011 and since then situations have become increasingly complicated. Under the Bank-supported WSSP, the Core Donor Group and the Government agreed to review and update NWSSIP based on new developments and the Bank allocated some funds for this purpose. Unfortunately, the government faced critical financial problems; the process was often without leadership. It is clearly important to revisit the NWSSIP given the current crisis, when there is the ability to do so.

The ministry is responsible for national planning and LC Boards are responsible for planning for their service area. De jure, responsibility for establishing national plans, budgets and targets for urban water supply and sanitation lies with MWE. Responsibility for establishing

sub-national plans, budgets, and targets lies with LC Boards, which include representatives both of local authorities (governorate, district) and of ministries. De facto, MWE carries out its assigned role, preparing strategy (NWSSIP and the NWSSIP Update) and conducting annual planning and budgeting in consultation with the Ministry of Planning and International Cooperation (MoPIC) and the Ministry of Finance. At the local level, LC boards do prepare plans. However, planning and investment decisions are taken at the center as LCs are dependent on central government and donors for investment finance, even though from 2009, the government and donors adopted a decentralized approach to planning and budgeting donor-financed investments in urban water supply and sanitation.

On setting and regulating water quality in public supply, de jure, the Ministry of Health is responsible. General Authority/Department for Awareness and Environmental Health (GAAEH), affiliated with the Ministry of Public Works and Highway, is responsible for regulating private drinking water purification stations. De facto, LCs self-regulate water quality. Private water supply is largely unregulated.

Financing Urban Water Supply and Sanitation

Cost recovery was below target in most LCs prior to the crisis and has since deteriorated further. As described in section 3, de jure, LCs are responsible for financing the design and construction of water supply and sanitation systems and for financing operations, management and maintenance from tariffs. *De facto*, LCs are dependent on central government and donors for investment finance. Attempts to pass on donor financing to LCs on a loan basis have been unsuccessful as cash flow has never been adequate to meet debt service. Before the conflict ensued, 15 out of 23 were recovering 100 percent of O&M and three LCs were recovering O&M costs and depreciation. Although short of the NWSSIP targets, and noting that in at least one utility O&M recovery was actually declining, this performance was not catastrophic.[1] The situation has considerably deteriorated subsequently (DAS 2016; DNA 2016; Ward 2015; Ward et al. 2009).

LC Boards set tariffs subject to guidance and regulation. The effectiveness of the process has been variable. MWE/TS provides guidance to the LCs on designing tariff structures but LC boards are responsible for setting their own tariffs. Due to misalignment of accountabilities, LC boards have sometimes opposed the tariff increases proposed by their own management. A draft decree to set up an independent regulator was prepared in 2010 but has never been adopted (NWSSIP 2004; NWSSIP 2008; Ward et al. 2009; MACS 2008a, b; Ward 2015, 238).

De facto, after tariff increases at the start of decentralization, tariff adjustments have continued, although they have sometimes proved irregular and problematic. Audited accounts at the level of LCs provide a more transparent basis than previously for justifying tariff increases. Before the troubles, 15 LCs were recovering 100 percent of O&M, and three were recovering O&M and all electromechanical depreciation. However, in at least one utility O&M recovery was actually declining (Ward 2015, 225; Ward et al. 2009).

The current low tariffs make it difficult for LCs to meet the cost recovery targets set and deter LCs from expanding services particularly in high cost or poor areas where network expansion would lead to higher deficits. Low tariffs also prevent LCs from accumulating surpluses to finance capital investment and reduce incentives for the private sector to participate in public-private partnerships. So far, decentralization of tariff decisions to LC Boards (although noting MWE must approve) has not always proved effective. In several cases, tariff increases required to make a service viable have been rejected by Boards, which have insisted first on service improvement, a Catch-22 that has hindered both network expansion and service improvement (Ward 2015, 225).

Human Resources

De jure, LC boards are responsible for staff recruitment and development and capacity building. LC staff report to their board. Senior staff appointments are subject to the approval of MWE and MoCS, and LC directors are appointed by MWE. Wage scales follow civil service scales

established by MoCS. NWSSIP set a norm that 5 percent of personnel costs were to be spent on training (NWSSIP; Ward 2015; Ward et al. 2009).

Management and staff quality is key and this is variable. Assessments have found some dynamic management, but also managers who do not feel empowered or who cannot adapt to a business approach. One study commented: "Managers are quite disengaged, they act like civil servants" (Ward et al. 2009). There is interference from the center and managers are often changed by MWE. For staff generally, constraints include poor incentives and weak capacity building and career development.

Some LCs have been able to reorganize and improve efficiency through staff development, training and performance-based incentives to boost the very low levels of salary. Management has improved with the introduction of new management systems, notably information technology and geographic information systems (GIS). Decentralization has empowered staff, although managers complain of "an incoherent governance structure, absence of accountability, and limited authority to take decisions." A computerized Human Resources Information System has been introduced, and LCs prepare training programs. Some national level training is provided by MWE/NWSA or projects but no LC spends the NWSSIP target of 5 percent of the personnel budget for training. In Sana'a LC the average is 1 percent (Ward 2015, 217–19; Ward et al. 2009).

Pro-Poor Orientation

The lifeline rate does give low cost access to the poor who have network connections. De jure, the 2008 NWSSIP Update required LCs to ensure affordable access for the poor while keeping the utility on a business footing. De facto, the main "pro-poor" practice of the LCs is to price the first 10 cubic meters of water supply per month at a low, cross-subsidized rate that gives the poor who are connected access to lifeline quantities (about 45 liters per capita per day [lcd], slightly less than the 50 lcd recognized as the "target livelihood need," but well above the 20 lcd "health threshold" set by the World Health Organization [WHO]). A number of studies in the Republic of Yemen show that this approach has been successful in giving the connected poor access to water at low cost, with consequent impacts on poverty alleviation and on health, gender, and education.

The unconnected poor have to source their water at higher social and financial cost. Most of the poor are not connected to LC networks, which tend to favor lower-cost, established settlement areas rather than the outlying, newly settled or steep areas where the poor largely live. The unconnected poor generally have access to free water from private wells or the mosque, but at a high cost of queuing and transport, with consequent impacts on household welfare in terms of time spent particularly by females and on health and education. Where the poor have recourse to tanker water, the cost averages about ten times the cost of network water.

Studies looking at pro-poor approaches in the urban water sector have found the following (Ward 2015, 238 ff; Ward et al. 2009):

- The pro-poor subsidy implicit in the lifeline tariff applies to all consumers, not just the poor and in many cases, as in Sana'a for example, half of all consumers pay only the lifeline tariff (table 3.1), which makes it harder for an LC to generate enough revenue to really help the mostly unconnected poor
- When the poor are connected, they may share a meter and in those cases end up paying the highest rates in the block tariff
- Some towns lack the revenue base to provide adequate cross-subsidy
- The relatively high connection charge and monthly fees for sewerage make the poor very reluctant to subscribe, even where sewer mains are laid

Water Security

Provisions of the Water Law to assign and protect water rights have proved ineffectual. De jure, the 2002 Water Law provides for state ownership of all water resources and for NWRA to allocate water to LCs and utilities under license and to declare and enforce protection zones in the catchment area of wells or springs (Water Law 2002). De facto, the licensing procedures have generally been followed by the LCs, which have applied for and received licenses for their public wells. However, private owners rarely respect the regulations. As a result, the protection zones have proved unenforceable in the Republic of Yemen's low governance environment. Random drilling and unregulated private abstractions have continued unabated. Attempts in Sana'a to reach agreements with local people on water sharing have had only limited success, largely because they have never been seen as fair by either side (Ward 2015; Ward et al. 2009).

NWRA has not been effective in top-down regulation. De jure, the National Water Resources Authority (NWRA) established by Presidential Decree # 154/1996 is responsible for allocating and regulating water resources under the Water Law of 2002. *De facto,* NWRA's capacity to assess, allocate, license and regulate water resources is very limited. LCs try to work with NWRA to source and regulate but often not effectively. However, neither NWRA, nor the LCs nor private well owners have been able to stem the unregulated development and abstraction of water.

NWRA needs to be strengthened for an important new role: working with local communities to support and guide community institutions in water management. In early 2011, before the crisis began, the cabinet adopted by decree a new "national compact" on water management enshrined in the *Sana'a Declaration for Water Management*. This stated a national commitment to "decentralized water management based on community action, local governance and participatory water resources assessment, supported by NWRA and other public agencies." This represents a reorientation of NWRA's role, away from attempts at top down regulation, which have had little success, and toward a role supportive of delegated local management. To fulfill this role, NWRA needs to be empowered by strong leadership, and stronger coordination should be established between NWRA and ministries (for example, Ministry of interior, Ministry of Justice, Ministry of Local Administration) at central and local levels in order for it to be in a better position to support efficient, sustainable water management. The well-qualified staff of NWRA are hired on a contract basis, and are supposed to be converted to civil service status. In many cases this has not occurred, leading to uncertainty among staff. More branches should be established at the governorate level to implement NWRA's mandate. Further, NWRA needs to accept the important role of local institutions and cooperate with them to work with communities at the local level to manage water sustainably and efficiently at the local level, within basin plans (Ward 2015, 204–06; Ward et al. 2009, 2011).

Rural Water Supply and Sanitation

Over the last two decades, considerable effort and investment have gone into a new "demand-driven model" of working with rural communities to improve access to safe water and sanitation. This section delivers an assessment of progress up to the start of the crisis and highlights the constraints that have emerged. The section looks in turn at: the operating model and sustainability; planning and budgeting; financing; human resources; inclusion of the poor; gender; rural sanitation and hygiene; securing water sources; and donor financing and coordination.

From 2000, public delivery of rural water supply and sanitation projects was also to be deconcentrated and driven by community demand and responsibility. De jure, Cabinet Decree 21 (2000) provides for government to deliver water supply and sanitation projects in rural areas

through General Authority of Rural Water Supply Projects (GARWSP) in consultation with communities on a demand-driven basis. Once the assets are created and the institutional mechanisms for operation and management are in place (a working water user association [WUA]), schemes are legally handed over to the WUA and become their entire responsibility. Community involvement and ownership were to be enhanced through the "demand-responsive approach" (DRA). At the same time, the Local Administration Law 4 (2000) provided for a weakly articulated district council responsibility for provision of water supply and sanitation services.

- Operating under MWE, GARWSP has been the lead agency for rural water and sanitation projects, delivering about two thirds of public projects annually. GARWSP was considered by government the sector leader with responsibility for sector-wide coordination, programming and monitoring and evaluation (M&E). Over the previous decade, GARWSP had been progressively deconcentrating responsibilities to its governorate level branches. Over this period, governance and management were considered to have improved considerably, but many questions remained (Ward et al. 2007; Ward 2015).

- The SFD was a large donor-supported public agency for CDD projects. SFD had an autonomous status reporting to the Prime Minister. It accounted for about 15 percent of rural water and sanitation projects and some/limited urban projects. SFD had a good reputation for efficiency and probity, and for innovation.

- The PWP was a large donor-supported public agency for public works projects delivered on a CDD basis. PWP had a good reputation for efficient implementation and accounted for about 15 percent of rural water and sanitation projects and some urban projects. *De facto*, SFD and PWP deliver about 30 percent of projects.

All three agencies (GARWSP, SFD, and PWP) have community outreach/social mobilization teams that work with communities on identifying and planning systems and on capacity building. Initially these teams were modelled on the three person teams (social mobilizer, technician, gender/health educator) pioneered under WSSP, but very varying levels of expertise and effort are now applied, with GARWSP the least compliant and competent in this area (Ward et al. 2007; Ward 2015; World Bank 2011). All three agencies require community contribution to investment, typically in kind (e.g., provision of materials, or labor for trenching). All three agencies provide some follow up support after handover, ranging from training and technical guidance, through supervision of WUAs, to support with major maintenance and replacements—although there is clear scope for more robust follow-up. GARWSP approach to working with WUAs and water user groups (WUGs) to engage communities has met with some success: in some cases, the community even offered to share 40 percent of total project costs. However, GARWSP still suffers from many challenges, including overstaffing of unskilled employees, interaction with local councils which lack experience and capacity to implement any project, and reliance on HQ for financing and expertise (JICA 2007). GARWSP more recently had shifted its focus on turnkey projects that deliver water services and ensure suitability of investments.

Any comparison of the three entities needs to be made cautiously: staff of PWP and SFD are well paid with good incentives, whereas the majority of GARWSP staff are civil servants with less opportunities for training and capacity building. GARWSP, being a public institution, is also providing its services with limited sources of financing. If the objective in the medium-long-term is to empower public institutions, GARWSP would be a prime candidate for strengthening. Its deconcentrated nature provides a basis to respond to demand more effectively. In designing any intervention or institutional reform, it would be important to look at ways the GARWSP staff could benefit from incentives, rather than designing a PMU in GARWSP, where difference of salaries or incentives between public servant or staff and PMU members may put the current strength of GARWSP as risk.

Further, a large number of traditional and modern water supply schemes are entirely private, largely community-financed and operated schemes. These schemes may receive support from government (for example, for help with rehabilitation), but this support can be sporadic.

For example, during election campaigns, some tribal leaders or influential people may use their influence with government, political parties, etc. to get funding either from the Ministry of Water, Agriculture, local administration, etc., for rehabilitation of schemes. There are also several national and international NGOs that support aspects of rural water and sanitation. These operate in conjunction with GARWSP but do not have major support from government (Ward et al. 2007; Ward 2015).

Although the government has set policy and technical standards for rural water supply and sanitation systems, there is considerable variation in practice. De jure, basic policy and technical standards are set by Cabinet Decree 21 (2000) and by the National Water Sector Strategy (NWSSIP 2008). De facto, the three public agencies involved (GARWSP, SFD, and PWP) each set their own standards within overall policy and there are considerable variations between them: for example, on water sources (SFD will not implement groundwater schemes), on community mobilization (SFD sets greater stock in up-front community commitments and organization), and on the importance of sanitation (which is supposed to be an obligatory accompaniment of water supply, a rule which is widely overlooked except by SFD).

Local authority involvement in rural water supply and sanitation is largely limited to approving agency proposals, as only relatively limited financial resources have been decentralized. Agency programs are endorsed by councils at the district and governorate level, and some local council contribution is required by GARWSP. However, the implementation of this approach has been hindered by the low level of financial resources which are actually decentralized (locally collected taxes and small block grants from the center).

Problems have arisen with the relatively high cost of running many of the schemes delivered, particularly in the rugged terrain with small and scattered communities. An unknown number of schemes have gone out of commission because communities could not afford to run them or because the water source dwindled and a new one had to be developed. Schemes set up by GARWSP, with its exclusively groundwater and pump-based technology, have particularly suffered. This problem has certainty been greatly exacerbated during the troubles, with the cost of fuel for pumps skyrocketing. SFD's answer has been to use lower cost options, including systems drawing on springs, streams, and water harvesting and manual pump technology (Ward et al. 2007; Ward 2015, 155–56).

However, the question arises regarding what should be the approach when there is no spring or stream or there are only limited options for water harvesting. For example PWP has simply eliminated from its program the communities that do not have access to a sustainable water source. Some innovative solutions are needed: rooftop rainwater harvesting; micro-dams for water collection; or local water transfers. All of these solutions have been applied by SFD (al Mujahid 2011).

More generally, sustainability of service provision is impaired by shortcomings in water resources management at the local level. All GARWSP and many PWP schemes depend on groundwater, which is widely overexploited, leading to depletion and drying up of aquifers. Schemes dependent on springs are also affected. Public agencies have no capacity to regulate abstractions, and local water governance has been widely undermined by changes in local power balances, by modern technology, and by market-driven incentives (Ward et al. 2007; Ward 2015).

Sustainability of schemes which depend on groundwater is often a problem, and agencies should help communities not only manage the water scheme but also work together to protect the water source Sustainability of investments in the rural water sector is worrisome given the anecdotal statistics that shows about 40 percent of the time when GARWSP drills wells that it will not find water, and even for those wells where water is developed, about 30–40 percent of the wells go dry within three to five years. The major reasons are drilling of wells by GARWSP without adequate feasibility studies in terms of water availability, and lack of enforcement of the water law (banning random drilling by powerful farmers who drill deeper wells closer to rural water supply wells that eventually lead to drying up of rural water supply wells).

It has been recommended that GARWSP should work closely with NWRA to insure that detailed feasibility studies have been conducted before drilling wells. It is further recommended that GARWSP should mobilize communities, form WUAs and raise their awareness in terms of the common-good nature of groundwater and the safe distance that should be respected between wells, which will help communities to protect their water supply and ensure sustainability of the services.

Planning and Budgeting

De jure, under Cabinet Decree 21 of November 22, 2000, MWE is responsible for strategy and for annual planning and budgeting, in consultation with MoPIC and the Ministry of Finance. GARWSP, SFD, and PWP are responsible for planning for their programs at district and governorate level, based on a transparent project application and approval process beginning at community level. The Local Administration Law 4 (2000) also provides for district council responsibility for planning for rural water supply and sanitation services.

De facto, all three agencies start from community demand and work up to establishing plans and budgets at district and governorate levels in consultation with local authorities. The community-originated investment application process and the decentralized screening have made planning and decision making more transparent than the old patronage-driven, bureaucratic and centralized decision-making mechanisms. The plans agreed at district and governorate levels are sent to the center where they are evaluated, trimmed, consolidated and approved in the national budget process, with the agreement of MoPIC and MoF. In the case of donor financing, the donor may have a major say at planning stage, but in many cases, Government usually requests the support, identifying its priorities and needs. Where local authority financial commitment is involved, the Ministry of Local Administration at the center will also review plans (Ward et al. 2007; Ward 2015). It is also important to note that there can be substantial variation of how planning and budgeting works across the districts.

A significant weakness in planning and budgeting has been that project delivery is split between the three agencies and there is no mechanism for joint planning at the local level or for consolidation, the elimination of overlap, or the exploitation of synergies either at central or local levels (Ward et al. 2007; Ward 2015). Coordination has worsened during the current armed conflict.

De jure, Cabinet Decree 21 (2000) provides for GARWSP to monitor sector performance. De facto, there has been only patchy respect of this requirement. Each agency consolidates information at governorate and national level. Before the troubles, for some years there was an annual review (Joint Annual Review, or JAR) at which consolidated data on scheme development and performance (all agencies plus NGOs) were presented to a national conference for analysis, discussion and decision. There is no good information on the number, coverage and performance of private and community schemes (JAR various dates; Redecker 2007; Ward et al. 2007).

Financing Rural Water Supply and Sanitation

As explained in section 3, de jure, Cabinet Decree #21 (2000) provides for central government, local government and community co-financing of capital costs and for community responsibility for financing O&M and replacements through cost recovery. The decree states that a capital subsidy will be provided by government, that schemes will be handed over to community WUAs, and that subsequent operations and maintenance (O&M) will be community responsibility.

De facto, all agencies delivering rural water and sanitation schemes follow variants of national policy. In general, the three principle agencies operating in rural areas grant a public subsidy with a per capita ceiling (usually US$100) and have a requirement for community cofinancing

of capital costs. Communities are encouraged to select the appropriate technology within the ceiling although in practice only SFD ever offers much choice other than a tube well scheme. Communities can upgrade by increasing their contributions. Many communities contribute extra to get house connections rather than standpipes. Community contribution is generally in kind (Ward et al. 2007; Ward 2015). Ownership of schemes is handed over once investments and institutional arrangements are in place, and the agencies generally provide support to capacity building, tariff setting etc. Private or community schemes are by definition self-financing, although they may attract occasional discretionary grants, for example, for a replacement pump or motor.

Human Resources

De jure, GARWSP and PWP are governed by civil service provisions applicable to their legal status, while SFD has its own statute and greater freedom in hiring and firing and setting salary scales. De facto, within these parameters, agencies recruit their own staff and are responsible for staff development and capacity building. Junior staff are typically recruited at local level, senior staff at central level. Agencies are responsible for their own staff development, with some pooling of training across agencies. SFD and PWP have been able to garner higher salaries for their staff (compared to for example GAWRSP), given that SFD and in some cases PWP are able to operate more like PMUs.

As mentioned earlier, any comparison of the three entities needs to be made cautiously: staff of PWP and SFD are well paid with good incentives, whereas the majority of GARWSP staff are civil servants with less opportunities for training and capacity building. In designing any intervention or institutional reform going forward, it would be important to look at ways the GARWSP staff could benefit from incentives, rather than designing a PMU in GARWSP, where difference of salaries and incentives between public servant or staff and PMU members may put the current strength of GARWSP as risk.

Inclusion: Pro-Poor, Gender

The requirement that agencies prioritize the poorest communities has helped but there are still many barriers. The problems of poorer communities have certainly been exacerbated by the diesel price rises and shortages of recent years. Even at the start of the troubles in 2011, increased water costs and shortage of diesel led to halving of consumption in some areas (JSEA 2012, 107; Ward et al. 2007; Ward 2015, 154, 172). De jure, Cabinet Decree 21 (2000) and NWSSIP provide for a priority to be given to the poorest districts and communities. De facto, many barriers to improving services for the poorest communities still remain. The Poverty and Social Impact Assessment (PSIA) found that a transparent application procedure and clearer eligibility criteria had helped but that poorer communities still had more difficulty in getting support and often had to settle for a lower level of service (Ward et al. 2007). By definition, poorer communities have more problems in meeting the financial eligibility criteria for investment and operations. Project selection and financing are subject to local political and personal forces implicit in the local council setup, which do not necessarily favor the poorest or the neediest. Decentralization of decision making may simply decentralize the play of patronage, influence and corruption to the local stage.

Another major gap is female participation. De jure, female participation in WUAs is required by Decree 21/2000, and it is a major emphasis of NWSSIP. De facto, although a Bank-financed project (RWSSP) achieved a female participation in WUAs of more than 10 percent, GARWSP, the lead agency, has neglected this requirement: in one year, out of more than 200 WUAs set up, only three included women. RWSSP trained more than 500 female “heath promoters” in health awareness messaging, but this capacity has disappeared since the closure of the project. SFD, however, maintains a strict requirement on both female participation and health education (World Bank 2011; Ward et al. 2007; Ward 2015, 162).

Rural Sanitation and Hygiene

Likewise, sanitation has not been given much priority. Following the completion of the Bank-financed Rural Water Supply and Sanitation project (RWSSP), SFD has been the only one of the three agencies to invest seriously in rural sanitation, under its Total Sanitation program. However, an evaluation concluded that a number of these projects are not operating satisfactorily for social and financial reasons. The rural sanitation situation remains appalling: according to the World Bank, more than two-thirds of the rural population "defecates in unmanaged open spaces." (JSEA 2012, 106; Robinson; Ward 2015, 162–63)

Levels of access to safe sanitation remain low and health education efforts by public agencies are weak, with consequent health and environmental risk. Even RWSSP, which had an explicit sanitation mandate, constructed only 2,385 household latrines against a target of 15,000. Hygiene education was, however, more successful, reaching an estimated 400,000 people (World Bank 2011). The main drivers of these poor results are the low levels of resources and energy that GARWSP and PWP devote to demand creation for sanitation and to health education, and the lack of drive and capacity within these agencies on these topics. Poor agency capacity and motivation is matched by sociocultural reticence about investment needs in sanitation at the community level, and the general reluctance to pay for something that is felt should be "free." Females, who are obliged to sneak out after nightfall, are the most disadvantaged but have the least voice. In hygiene, women are disempowered by ignorance. Politicians and decision makers are reluctant to invest public funds in what they see as a secondary need and possibly as the responsibility of the household, and agencies are reluctant to push for something that is not very popular (either on scorecards or in their hearts). Only donors have pushed the issue and this external influence may actually have hardened resistance (Ward 2015, 174).

Water Security

Although the NWRA, established by Presidential Decree 154/1996, is responsible for allocating and regulating bulk water sources, in practice agencies work with communities to identify water sources, and communities are subsequently responsible for resource protection, which often proves very difficult. De facto, NWRA's capacity to assess, allocate, license, and regulate water resources is very limited. The three agencies generally work with communities to identify viable sources, although they may then seek a license from NWRA. However, sources have often proved to have limited sustainability, and there is a difficult history of dispute between the agencies and communities, and within and between communities. WUAs essentially regulate locally to protect their source to the best of their ability. In practice, SFD has concluded that groundwater sources are unsustainable and this agency mainly works with springs and water harvesting (Ward et al. 2007; Ward 2015).

Examples show the potential for communities to recover some measure of control over groundwater and protect their drinking water source, although the examples are location specific and may be hard to scale up. In the past, the Republic of Yemen was considered to have excellent community-based models for surface water management. These models depended on the locations in term of topography (mountains, plateaus, deserts, coastal areas, and so on) as well as the scarcity of water (in term of quantity of rainfall and evaporation). Unfortunately, these systems deteriorated since the 1970s due to the introduction of the new drilling technologies and abstraction of groundwater. Today, there are many horror stories, but also examples of communities that have successfully recovered control over the resource–or at least protected their drinking water source. These cases are often specific to location and community–there is no "one size fits all." As the number of stakeholders increases and the types of water use become more varied, the model becomes more difficult to replicate. This can be seen in the lower part of Wadi Siham, in the Tihama coastal plain. Due to a "water boom" that emerged during the 1980s, several Yemeni investors bought big lands and invested on agriculture. The well fields of Hodeidah LCs supplying drinking water to the city

also are located on this area. Several industries were established along the main roads between Hodeidah, Taiz, and Sana'a. All of these activities attracted many people from different parts of the country and even abroad. Eventually, management of the water resources faced serious challenges due to the diversity of water uses and the lack of enforcement of laws and regulations.

In many parts of the country, there is a major problem of dwindling water resources and the related challenge of inadequate local water resources governance, unable to protect rural potable sources against the pressing competing claims. Many rural schemes nationwide (nobody knows quite how many but guesses rise as high as half of all schemes) have gone out of service because the water resource on which they depend has simply dried up. The underlying problems here are that neither traditional governance institutions nor modern state top-down regulatory mechanisms have been able to stem the strong competition and elite capture which has been enabled by new technology and driven by profit. GARWSP has been responsible for the drilling of many wells, without adequate feasibility studies looking into water availability, and has not been a strong enforcer of the water law. The three agencies should work much more closely with communities and the NWRA (who in turns needs to seriously enhance capacity) to ensure that detailed feasibility studies have been conducted before drilling wells.

Groundwater Governance

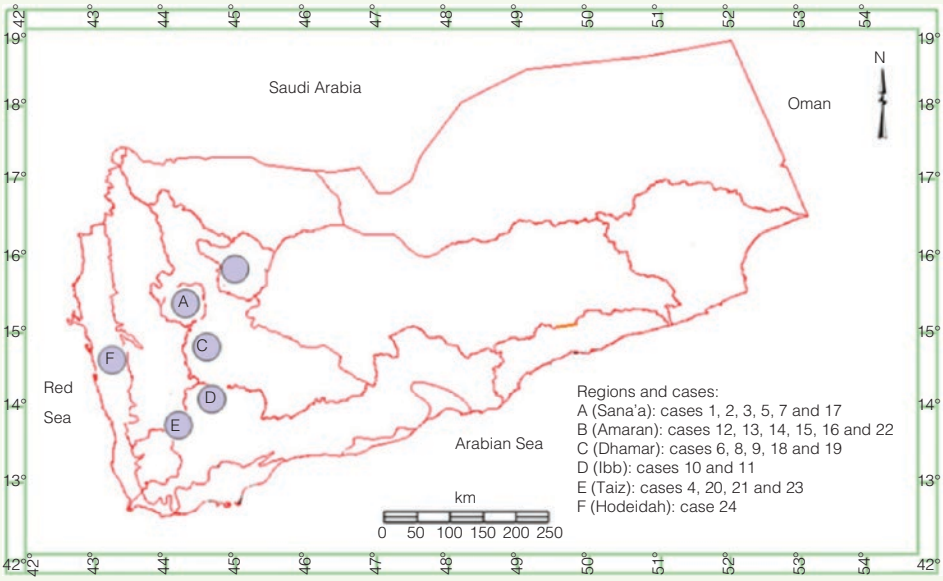
A critical issue for both rural and urban areas is local groundwater governance. The Republic of Yemen has a predominately-arid climate. Only about 6 percent of rainfall is captured in the surface-water system in wadis as spate (flood) flow. Groundwater is a vital source for water use throughout The Republic of Yemen. The rate of groundwater overdraft is currently twice the recharge rate, and is increasing, bringing depletion of water reserves, inequity and shortages, with negative socio-economic consequences. Historically, The Republic of Yemen developed elaborated systems of formal and informal norms, rules and laws to govern the use of its water resources, primarily surface water, in a sustainable and fairly equitable manner. The Republic of Yemen's heritage of managing water includes social capital of institutional arrangements for leadership, water allocation, resources mobilization, and conflict resolution. The Box below describes some of the local governance practices with respect to groundwater management.

Box 4.1: Local Groundwater Governance in the Republic of Yemen

The enabling factor for the local groundwater management in the Republic of Yemen can be summarized as follows: (a) Wealth of traditional knowledge in water resources management; (b) Increased depletion of groundwater; (c) Institution water-sector reforms; and (d) Raised competition/conflicts over water.

The most common results of groundwater felt by the local communities are increased well depths, increased pumping costs and reduced water quality. Local water users in some areas of the Republic of Yemen have taken steps to prevent further harmful development of water resources, avoid wasteful use, harvest rainwater, replenish groundwater, and ensure access to water for drinking and domestic use. The included map depicts the location of examples of local groundwater management in the Republic

box continues next page



of Yemen. These examples were relatively easy to find in the highland districts, but less in the coastal areas, probably due to the larger complexity of the water systems (conjunctive use of spate irrigation and groundwater) and larger aquifer systems. In general, the local rules can be categorized based on their purpose under two types:

(i) Rules which preserve common interests: These include closed or restricted usage of wells that interfere with drinking/domestic water sources, preventing water transfers from the are to urban areas/sale of water, restriction on water withdrawal from dams and rules governing management of recharge structures.

(ii) Rules which preserve individual interests: These include respect of minimum spacing between wells, limitation on maximum well depth, and right of individuals to share/buy water from existing wells.

From the examples of local management in the Republic of Yemen, several conclusions can be drawn:

(i) There is a high level of collective local management. Communities establish informal mutual agreements on local rules which consist of measures such as well spacing, closure of disputed wells, and bans on sales to water tankers.

(ii) Local management in some cases was encouraged by projects such as the awareness and social mobilization activities under the World Bank-funded Sana'a Basin Management Project or the Groundwater and Soil Conservation Project. In other cases, communities came together after seeing disaster striking nearby areas or having been faced with conflicts occurring in their own area.

box continues next page

(iii) The water law and licensing procedures embedded in it are important. The fact that wells in principle need to be licensed has conspicuously signaled that groundwater is no longer an open access resource and restrictions should apply.

(iv) Where local groundwater management is in place, the initiative may be taken by a local sheikh, by another respected leader or by a water user association. There may be many sources of local leadership, not necessarily the traditional sheikh.

(v) The local rules and regulations concern a broad range of measures—location and depth of wells, recharge measures, management of reservoirs and in some exceptional cases, cropping bans.

(vi) Community-based organization take multiple forms: informal and formal, small and large, for piped domestic supply and for irrigation, and already play a significant role in water management, particularly in the operation and maintenance of piped drinking-water systems.

(vii) Efforts for the development of agriculture and the water sector during the last 40 years were generally stated centered and often ignored or disrupted local traditions of water management.

Local groundwater regulation are feasible and yield specific, practical benefits such as reducing conflicts. However, local efforts are often constrained by various factors, including lack of technical understanding of aquifers, lack of knowledge about effective approaches, and lack of external support of enforcing rules. Considerable scope exists to further promote community groundwater governance in the Republic of Yemen. The following options can be suggested to support rural communities: (a) promote awareness and knowledge extension on water related issues; (b) incorporate informal management into water sector formal management policies; (c) revive and adapt customary and traditional rules; and (d) develop simple monitoring tools for the local water users.

Source: Taher et al. 2012.

Donor Financing and Coordination

In principle, donors are supposed to simply finance government-led strategy and programs. De jure–and in line with donor best practice as set out in the Paris Declaration–donors are working with MPD and to providing "harmonized and aligned" support within government-determined strategies and government-led programs. In a very low governance environment with weak institutions and low accountability, donors have been key: pushing for equity, efficiency and sustainability; coordinating amongst themselves and aligning with official policies; pushing for specific reforms, notably DRA, GARWSP reform and decentralized, sector-wide approaches; and ensuring monitoring, supervision and exchange of information on sector performance (Ward et al. 2007; Ward 2015).

De facto, there have been past weaknesses in donor approaches to rural water supply and sanitation. Despite many efforts to collaborate over the last two decades, key donors have often followed divergent approaches to rural water. All are aligned on DRA and on NWSSIP, but there have been wide divergences of approach over the lead sector agency, GARWSP.

The World Bank has tended to work through alternative agencies. For several years, the World Bank financed a free-standing RWSSP with ephemeral project status; it was weakly reintegrated into GARWSP at closure, with substantial loss of learning and capacity. More recently, the World Bank has tended to also work with SFD and PWP. By contrast, the Netherlands has pushed for implementation through GARWSP as the dominant provider, but has not accompanied this push with adequate strengthening of GARWSP governance, fiduciary and M&E systems, and capacity building (World Bank 2011; Ward et al. 2007; Ward 2015).

Note

1. This level of coverage of O&M costs is in fact not far below the global median of 109 percent (Danilenko et al. 2014, based on data from over 1,000 utilities worldwide).

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Chapter 5

The Ongoing Violent Conflict and Urgent Reconstruction Needs

The ongoing conflict in the Republic of Yemen has resulted in a catastrophic humanitarian situation.[1] In May 2015, the United Nations (UN) placed the Republic of Yemen at level 3 of humanitarian distress, the highest categorization of countries in conflict. The conflict's escalation in March 2015 amplified an already existing protracted crisis, characterized by widespread poverty, conflict, and poor governance. According to the 2017 Yemen Humanitarian Response Plan, as of December 31, 2016, the conflict has caused nearly 48,000 causalities, including nearly 7,500 deaths. The death toll and humanitarian misery continue to rise with the conflict protracting. In addition, out of 18.8 million of people affected, 9.6 million are children, of which 1.6 million children are internally displaced; 462,000 children under five years are at risk of severe acute malnutrition (SAM); 14.5 million people are in need of Water, Sanitation, and Hygiene for All (WASH) assistance; and 14.8 million people are in need of basic health care.

About half of the nation's population of about 26.8 million lives in areas directly affected by the conflict. Over 21.1 million Yemenis (80 percent of the population) are in need of humanitarian assistance, and over 3 million Yemenis are internally displaced people (IDP) by force.[2] Severe food insecurity affects 7.6 million people, and an estimated 2 million are malnourished, including 1.3 million children, of whom 320,000 are suffering from acute malnutrition. Basic services across the country are on the verge of collapse. According to the World Health Organization (WHO), as of January 24, 2017, 18,194 acute watery diarrhea (AWD) and cholera cases and 99 deaths (case fatality rate [CFR] of 0.5 percent) were reported in 165 districts. Of these 8,869 (49 percent) are women, while 6,144 (34 percent) are children below five years old. AWD and cholera cases were mostly reported from Al-Hudeidah (22 percent), Taiz (13 percent), Albayda'a (11 percent), Ibb (10 percent), and Aden (9 percent). Aldala'a reported 8 percent, and Hajjah, 7 percent. The overall rate is 7.7 per 10,000 of population. This rate indicates a rising need for more intervention in the following high-risk districts: Mokiras (64 percent), in Al-Bayda'a, Dar Sad (39 percent) in Aden, Al-Husha (34 percent) in Aldala'a and Al-Hali (65 percent) in Al-Hudeidah.

According to the United Nations International Children's Fund (UNICEF), water networks in rural and urban areas have reduced or have stopped functioning, and local water corporations in most cities are no longer able to maintain or rehabilitate the infrastructure. The near collapse of the public WASH systems is a direct result of damages caused by the war, fuel shortage to run water pumps, lack of back-up generators and financial resources for operations and maintenance, unpaid salaries of civil servants for about 6 months, and the inability of consumers to pay water bills. In addition, sewage treatment plants and solid waste collection in many areas have been suspended due to direct damage from airstrikes, lack of fuel to run generators and garbage trucks, fighting, and non-payment of staff salaries. The declining trends in access to safe water and adequate sanitation and hygiene facilities are leading to a potential public health crisis.

Regarding IDPs, according to a Rapid Assessment Report of two Yemeni districts undertaken by UNICEF and Action Against Hunger issued in March, 2017, IDPs are facing real access constraints to WASH. In the districts of Khanfar and Zingibar, 12 percent of the assessed IDP population rely on unprotected sources of water, and only 17 percent have access to a hygienic latrine. It is important to note that the assessment highlighted the emerging trend

that some IDPs are already being hosted by relatives and friends who are already in need of humanitarian aid and assistance, including WASH-related. The report therefore recommends that humanitarian aid attempts cover the needs of both IDPs and host community to negate any negative effects like tensions that may result by targeting IDPs only (UNICEF and Action Against Hunger 2017).

Poverty, already high before the conflict, has further increased. Before 2014, the Republic of Yemen was already profoundly challenged by high population growth, severe urban-rural imbalances, food and water scarcity, female illiteracy, widespread poverty, and economic stagnation. The ongoing conflict is likely to have fundamentally altered the social and economic landscape and increased poverty levels. Initial simulations of the conflict's impact show that the poverty incidence may have almost doubled nationally from 34.1 percent in 2014 to 62 percent in 2016.[3]

Economic distress, social impact is mounting. The conflict-related losses and damages were estimated as of the end of 2015 at US$19 billion, based on a preliminary joint assessment of the World Bank, the UN, the Islamic Development Bank, and the European Union (EU). The conflict and the associated deterioration in conditions have not only caused physical destruction of infrastructure but they have also deepened the economic crisis, severely impacted the social fabric of the society, and further worsened living conditions. In 2015, the economy contracted by about 28 percent. Oil production and exports, the mainstay of the preconflict Yemeni economy, halted. Inflation reached about 40 percent in 2015. The fiscal expenditure program shrunk by about one-third in 2015, reducing the state's share in the economy to around 20 percent. Essentially the government could finance only salaries of public employees but had no resources to maintain such public services as water, health, and education. The situation in 2016 has worsened, with salary payments being outstanding to most public employees since August 2016.[4]

Damage Needs Assessment

Since early 2011, the political instability and armed conflict have noticeably aggravated water service delivery, leading to direct and indirect effects on water infrastructure and management operations. The Ministry of Water and Environment (MWE) published the latest cost estimate of damages on water infrastructures as of February 2016, indicating that the costs may reach to more than US$170 million (MWE 2016).

Phase 1 of the Damage Needs Assessment (DNA), indicates that water infrastructure—including distribution systems, pumping stations, water tanks, and well fields—were heavily damaged in some cities and towns. Notably, such damage has disrupted water deliveries in Aden, Taiz, Zinjubar, and Sana'a.

Further, media sources, including TV and press interviews with local water corporations indicate that many more water utilities have partially or totally halted services during 2015 because of physical damages and the lack of fuel supplies, long periods of electrical outages, a huge lack of revenue collection, water theft, tampered water meters, and high absenteeism among unmotivated technical staff who must work without salaries (Photographs 5.1 and 5.2).

The public water distribution networks suffer from chronic intermittent delivery, but the conflict has extended such intermittency to the point where thousands of households across the country must resort to searching for additional water sources. These households often collect water from mosques or from donated standpipes and tanks, purchase water from private tanker trucks, or harvest rainwater (Al-Mujahed et al. 2015; Donaghy 2015).

The business of private tanker trucks has been flourishing over the past five years in both rural and urban areas, and is currently the major source of domestic water in many cities and towns (including Sana'a, Taiz, Ibb, Mahwait, and Manakha). Even though the private water tanker trucks,

Photograph 5.1: LCs in Hadramout Request Customers to Pay their Water Bills

Photograph 5.2: Sewage Breakdown in Hodeida

Source: http://www.alwatanvoice.com/arabic/news /2015/09/22/780938.html#ixzz4GRYzbdAK.

like other businesses, suffer from high prices and shortages of fuel, they have leveraged their comparative advantage to purchase fuel from the black market to continue their operation (Alsharmani 2015). Fuel price increases—and related price increases have caused water tanker prices to more than double: "the price of a water truck delivery was YRI 2,000 in parts of Al Hodeida before the conflict, it is now YRI 8,000. In Sana'a, where a delivery cost YRI 4,500 before, it costs YRI 10,000 now" (Human Right Consultant 2015; OXFAM 2015).

Box 5.1: Key Reconstruction Challenges Facing the Republic of Yemen's Water Sector

- Water scarcity, exacerbated by conflict, could trigger further conflicts
- Supply chain constraints include lack of fuel, power, conveyance, nonrevenue water including increased theft, unpaid salaries (leading to absenteeism), source depletion
- Cost of private (tanker) water is high and water quality is questionable
- AWD and cholera cases have been linked to lack of WASH services
- Physical damage to water distribution system including to pumping stations, water tanks, and well fields
- Lack of fuel supplies and electricity that stop the operation of pumping stations and treatment facilities
- Selling of Local corporations' (LCs') appropriation of oil products to the black markets
- Vandalization and theft of LC property including cars, water meters, chlorine, oil products, sewage covering caps, copper electrical cables
- Proliferation of checkpoints, making it challenging and dangerous for tanker trucks to transport water
- Lack of backup generators to operate wells, pumping stations and the treatment in case electricity is cut off
- Lack of backup equipment and spare parts for wells and producing plants
- Shortage of wells that can be used as backup for emergencies
- Insufficient funds to cope with emergency needs

Sanitation services have also been severely impacted by the political crisis and armed conflict. According to multiple media outlet sources, the number of sewage system breakdowns have increased dramatically over the past four years due to lack of maintenance caused mainly by the reduction of revenues to pay workers. Most of the sewage leaks are taking place in Hadhramout, Hodeida, Taiz, and Aden. Heightened health risks, together with food and water insecurity, have become the daily burden on the majority of Yemeni households.

Additional challenges described by senior Local corporation (LC) officials[5] (Alsharmani 2015) (see examples in box 5.1).

Urban Water Supply and Sanitation

The German Agency for International Cooperation (GIZ)-executed Damage Assessment Study (DAS) have given estimates of damage to urban water and sanitation infrastructure in several cities (see box 5.2). These estimates will need to be confirmed and a rapid institutional status assessment will be required to determine what capacity exists in the LCs or at the National Water and Sanitation Authority (NWSA) for procurement of immediate needs. Several LCs have specialized procurement units, largely to deal with donor projects, and these may still have capacity.

Box 5.2: Damage Assessment in 12 LCs

A 2016 study by GIZ reveals the status and needs of the Republic of Yemen's urban water and sanitation system, based on a survey of 12 LCs. There is a very large number of IDPs everywhere and a very difficult socio-economic situation with widespread shortages of basic necessities and high prices. A large number of people are without access to improved water and sanitation. The situation of the utilities is very difficult, characterized by negative cash flow, depleted bank balances, budget shortfalls, high levels of unpaid liabilities and receivables, and drying up of fiscal and donor transfers. The difficult cash situation has led to nonpayment of salaries, and many staff are no longer working. There has been widespread physical damage and pillaging, with many wells out of operation and widespread destruction of networks, resulting in growing interruptions in water supply and increase in nonrevenue water. Investment and expansion are at a halt almost everywhere.

Immediate actions include the following:

- Immediate cash infusions to pay salaries and procure supplies and fuel
- Repair of major damage
- Rehabilitation of wells and pumps
- Re-equipment of operation and maintenance capability
- Reconstruction of offices
- Emergency sanitation and health education provision

Source: DAS 2016. The Republic of Yemen Water Sector: A Managerial, Financial, Human Resource, Operational Structures Assessment of Twelve Water Corporations, and their Affiliated Utilities. GIZ Sana'a/Eschborn.

Rural Water Supply and Sanitation

A localized (deconcentrated or decentralized) approach will be essential, but support will be required from central agencies. A rapid institutional status assessment will be required to determine what capacity each of the main agencies has (General Authority of Rural Water Supply Projects [GARWSP], the Social Fund for Development [SFD], and the Public Works Project [PWP]) and for what type of interventions. All other capacity should also be included (UNICEF, Save the Children, Oxfam, and national nongovernmental organizations [NGOs]). These agencies and their staff should then be incentivized to form governorate and district-level teams to conduct (a) joint identification of needs; (b) preparation of a recovery and reconstruction program; and (c) implementation, with roles determined by the procurement and field delivery capacity of each agency and its skills in the required technology. A possible implementation set up could be: PWP carries out procurement; GARWSP and PWP take care of pumped schemes; the Social Fund for Development (SFD) takes care of "other technology" schemes such as rainwater harvesting; and SFD, UNICEF, and NGOs take care of community mobilization, monitoring, and reporting at local level and capacity rebuilding.

Security will be needed and government and donors will need to be involved from the outset. None of this can take place unless there is a reasonable measure of security and stable administration over a wide enough area. The approach and programs will need to be agreed with government input as far as possible, at both central and local levels. Donors will need to

be ready to appraise the programs, and to provide financing and support procurement as soon as possible. Donors will need to make sure that actions in the short term are consistent with—and as far as possible contribute to—the longer term vision of rural water and sanitation within the National Water Sector Strategy and Investment Program (NWSSIP).

Immediate Options for Reconstruction

Based on the assessment to date, there are four broad tracks for immediate and urgent interventions that should be considered:

- Restore basic water and sanitation service
- Maintain capacity and enhance resilience of local institutions
- Support innovative service delivery and private partners
- Improve planning, coordination and reporting on sector interventions

The most critical short-term reconstruction needs involve stabilizing urban water supply and sanitation services to restore basic service delivery and keep public health threats in check. These are suggested activities going forward:

- Rehabilitating and re-equipping of deep tube wells
- Rehabilitating water pumping stations
- Reconstructing and rehabilitating water storage tanks
- Supplying the utility with equipment and machinery (mobile fuel tanks, generators and transformers, laboratory equipment, service vehicles) for operation and maintenance
- Improving and restoring destroyed water networks (main pipelines with maintaining and installing pumps)
- Drilling new wells (when adequate provided availability of feasibility hydro-geplogical and geophysical studies)
- Rehabilitating the sanitation system including vacuum trucks; sewage networks; sewage collection lines, sewage pressure lines, and wastewater collection networks; lifting stations, small mobile sewage pumps; inspection champers and manhole covers; stores, buildings, and offices; and sewer rods

Some of the activities should inherently be designed to generate jobs and provide opportunities to local contractors, which may help to normalize the situation and support the peace-building process.

In addition, these following activities should be emphasized to improve urban water supply and sanitation provision:

- Overcome power outage and diesel shortage related issues. For example, have backup generators and backup storage tanks; install metering systems to monitor diesel use by generators and pumping stations; procure and store backup treatment materials and spare parts; have reserve fuels and mobile fuel tanks with different capacities; install elevated towers, lifting stations, and transformers; and evaluate the efficiency of pumping stations (that is, use those with a higher efficiency rate and reserve low-efficiency ones for emergencies).

- Establish distribution stand points at poor neighborhood and IDP areas. Pamphlets of emergency programs should be sent to governorates and local councils to help establish water user groups (WUGs) across cities, towns, and villages to study the water needs of each neighborhood and decide if there is a need to establish a distribution standpoint or whether to provide more storage tanks (for example, next to or with the help of mosques) for drinking and cooking for low-income families.

- Distribute water filters for water purification and as a disease reduction method. Since the conflict, private tankers have been the main source of drinking water. Because this source of water may be shallow and of poor quality, and with the lack of chlorination and other quality monitoring, cholera has been reported to have spread in several cities.

- Reduce water theft and increase revenue collection for utilities. Sensitization campaigns to overcome water theft could focus on adverse impacts through the help of mosques and neighborhoods leaders. The programs could establish a mechanism for community participation to help LCs discover and prevent violations on meter tampering and other practices. LCs could install anti-theft water metering systems with wireless sensing to alert authorities on tampering. They could also install an advanced complaint system to report flaws such as broken pipes, which gives customers a chance to provide feedback and to strengthen their loyalty. With improved services, the willingness to pay should be increased.

- Rehabilitate damaged rural water supply systems to prevent disease outbreaks in rural communities and rebuilding of rural livelihoods. The interventions could focus on rehabilitating community water project, including wells, pipes, water tanks, and connections.

- Partner with private water suppliers. Given that private suppliers (wells, private networks, tankers, purification shops, bottling plants) provide water services to thousands of households, it is imperative to form practical partnerships with these providers. Creating partnerships and ensuring that private operators have access to fuel should increase supply and bring down costs. Private tanker trucks could be contracted to deliver water to households from LC well fields to customers at affordable prices. An increased number of private agricultural wells could be converted to urban use if, for example, the government supported the development of community associations for water sales and underwrote and supervised contracts for communities to sell water to urban areas either by tanker or by pipe. These approaches would help increase supply and bring down prices, and would also be an entry point to encourage more sustainable use of water resources and regulate standards for quality drinking water.

It is critical that even emergency interventions at the minimum consider a “do no harm” litmus test to the fragile partnerships and existing institutions, and in particular water resources management. Ideally, any of these interventions should be considered in line with strengthening the central and local entities responsible for service delivery, especially when working with alternative suppliers, since capacity development and knowledge transfer, along with job creation, are critical for medium- and long-term ownership and sustainable financial and water resource solutions that contribute to peace and stability.

Notes

1. This introductory section taken from the Yemen Emergency Health and Nutrition Project PAD, November 2016.
2. https://www.iom.int/sites/default/files/situation_reports/file/IOM-Yemen-Crisis-Sitrep-24Mar-6Apr2016.pdf; http://reliefweb.int/sites/reliefweb.int/files/resources/2016_HNO_English_%20FINAL.pdf.

3. The poverty headcount is based on a national poverty line of YRI 10,913 (or about US$50) per capita per month in 2014 prices. In terms of 2011 purchasing power parity (PPP), about US$3.52 per person per day, or about US$105.6 per person per month.
4. Valid as per October 29, 2016, the day of writing this part of the document.
5. https://www.youtube.com/watch?v=BABSP6zMe9o.

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Chapter 6

Future Vision for Service Delivery and Sustainability

It is beyond the scope or ability of this analysis to suggest concrete institutional reform solutions for the Republic of Yemen's water sector, given the high level of uncertainty across every level, whether available infrastructure and new needs, institutional and technical capacity, or even the level of government and decision-making that may exist as soon as a peace agreement is signed.

Yet there are lessons to be considered regarding the design and execution of future interventions. At the minimum, interventions should try to manage to "do no harm," or more aptly, to maximize efficiency of water resources used, given the absolute dire situation of water resources in Yemen. Ideally, interventions should ensure coordination and most effective use of both physical and financial resources. The analysis highlights that access to sustainable water and sanitation services was deteriorating prior to the conflict, although some gains had been made.

The challenges facing the Republic of Yemen's water sector are immense. These have been described or alluded to earlier in this document. Meeting these challenges requires paradigm shifts in the way the sector and the country has been trending. This chapter contains specific considerations for next steps, including areas for further analysis, being cognizant that this Diagnostic has been undertaken as a desk-based analysis and of course given the on-going conflict and the clear limitations on data availability and verifiability. While being cautious in proposing big shifts in the institutional structure of the sector given the large political uncertainties at this time, this chapter highlights key considerations for the future vision of the water and sanitation sectors in the Republic of Yemen, which are centered around the following:

- Considering the stewardship of water as a resource and inter-basin cooperation by either strengthening existing institutions or considering supplemental arrangements, including the National Water Resources Authority (NWRA) and its branches at the governorate

- Greater coordination across the water-agriculture-energy nexus to maximize efficiency of use, noting in particular that the agriculture sector is using more than 90 percent of the water resources

- Supporting the central agencies involved with water and sanitation services including regulatory agencies, as well as their deconcentrated branches

- On the urban side, providing technical and financial support to urban utilities and local governments, including efficient financial flows and tariff-setting arrangements to encourage expansion, efficiency and sustainability, and on the rural side, supporting the General Authority for Rural Water and Sanitation Projects (GARWSIP) as well as the water user associations (WUAs) and communities with regards to operations and maintenance (O&M) as well as water stewardship at local level

- Working with alternative service providers such as nongovernmental organizations (NGOs) and private sector tankers to ensure greater reach (including the role of tankers for the transfer of bulk water), while ensuring safer quality, fair pricing, and sustainable use of resources

- Consideration of the impact on and interlinkages with child and maternal health and nutrition, especially in light of the food security crisis, when developing interventions

- Learning lessons from past interventions by not repeating failed approaches but rather testing new and innovative ones for example in those areas which have repeatedly remained unserved, while replicating and scaling-up successes where possible

- Coordinating more efficiently among donors

Focus on Water Security

The Republic of Yemen is heavily overdrawing on its water resources, with agriculture consuming most of the water. Water resources for urban supply have always been scarce, particularly in the highlands, and new supplies have become increasingly costly and hard to find. Existing sources are rapidly depleting as utilities and other users overpump existing nonrenewable resources. The annual renewable water resource is about 2.5 billion cubic meters (bcm), of which 60 percent is groundwater and the rest is surface water. The current annual water use is about 3.9 bcm with an overall annual deficit of 1.4 bcm (MAI 2013). The gap between supply and demand is being bridged by withdrawing fossil groundwater resources, which reduce the water table by an average of 1–7 meters. The domestic and industrial sectors consume about 10 percent of total water use with the agricultural sector accounting for the other 90 percent (CES 2008; UN ESCWA 2015).

One of the biggest challenges for the Republic of Yemen is to develop sufficient and sustainable water resources to meet the mounting water demands caused by continuous high population growth rates and the demand for economic development (World Bank 2006a). The nation's population was about 25.2 million in 2013 with an annual increment of 3.0 percent, while urban population growth averages 4.9 percent rising to a maximum of 7 percent in the capital city of Sana'a (CSO 2014; USAID 2012). Given such high population growth, the annual per capita renewable water resource has declined from 221 cubic meters in 1992 to only 80 cubic meters in 2014. This volume is a scant 1.3 percent of the global per capita average (5,925 cubic meters) and just 14 percent of the Middle East and North Africa per capita average (554 cubic meters) (World Bank 2016). As a result, several major towns are essentially running out of water: Ta'iz experiences extreme water stress; Sana'a is closing on average six existing wells each year and expansion is constrained by lack of new sources; and Ibb and Mahweet are suffering growing constraints (Ward 2015, 205).

The underlying problems are (a) the Republic of Yemen is generally very water scarce and population growth especially in the urban centers.; (b) water has been appropriated everywhere largely for agricultural use adopting traditional irrigation methods, given the subsidies (diesel, pumps, digging of wells) provided by government to the farmers at specific point of time.; and (c) the lack of water resources governance and regulation has meant that there is no enforceable system to allocate water resources to urban use or to protect these resources from infringement by other users. Despite the provisions of the Water Law, the institutional mechanisms for allocating resources to urban use are too frail to restrict competition from private, largely agricultural demand. Uncompensated urban appropriations of water from rural areas are widely seen as unfair.

Water for cities is one of the biggest challenges facing the Republic of Yemen. Water resources for urban supply have always been scarce, particularly in the highlands, and new supplies have become increasingly costly and scarce. Existing sources are rapidly depleting as utilities and other users overpump existing nonrenewable resources.

There is currently no institutional mechanism for transferring water from rural areas for urban use. Despite the provisions of the Water Law, the institutional mechanisms for allocating resources to urban use are too frail to restrict competition from private, largely agricultural demand. This also include the weak role of NWRA which is responsible about allocating, regulating and monitoring the water resources over all the country. Up to now, towns have

drilled deeper in the peri-urban area and drained out the water. Rural communities in the areas overlying the groundwater aquifers see their springs and wells drying up. Not surprisingly, they often regard these uncompensated urban appropriations of "their" water as unfair.

The utilities have to not only to identify new sources but also to develop sustainable and equitable models for rural-urban water transfer that could be replicated on similar social and hydrogeological conditions. Policy makers have proposed several models for transfer of water on the basis of equity, sustainability, and "no uncompensated harm." These largely rely on rural communities organizing into formal self-regulating WUAs to contract with urban utilities for rural-urban transfer within basin plans, and on agreements to reserve certain resources for potable use (for example, the deep Tawilah sandstone aquifer underlying the highlands especially in the southern part of Sana'a city).[1] Increasing reliance on regulated private water supply is also likely to ease the challenge of sourcing water, since private contractors or community organizations tend to have their own ways in which they negotiate with water users (Ward 2015, 206, 364–66). Other possible alternatives depend on location: communities close to the sea have the desalination option (although costly), while others especially on the mountainous area of quite quantity of rainfall may consider, for example, rainwater harvesting.

Adequate and sufficient hydrogeological and geophysical assessment studies have not been carried out to evaluate the storage capacity of the groundwater aquifers and water quality as well as its sustainability for further investments, but are urgently required. Regarding rural water security, sustainable local water resources management (WRM) requires communities to take responsibility going forward, in terms of prioritization of needs, planning, implementation and operation and maintenance of schemes. To combat the strong competition for water and the fact of elite capture, rural communities will need to be supported in community approaches to ensure sustainable water management in the area, both within communities and between neighboring communities given the tribal nature and sensitivities of the society to water scarcity. Government agencies will need to provide strong support, preferably through NGOs, building on recent success with decentralized water management approaches. Further, the General Authority of Rural Water Supply Projects (GARWSP) should work more closely with the NWRA to ensure that detailed feasibility studies have been conducted and permission/license have been granted before indiscriminately drilling wells. Of course, the "political economy" of this issue is highly variable across communities, with different institutional setups and local power relations in each community. Addressing the challenge of local water management is an immediate need, but results will be slow and this issue will require sustained effort.[2]

The water-agriculture nexus needs to be explored, although this topic is not covered in this WASH diagnostic (which focuses on WASH service delivery). Any efficiency gain or reduction in irrigation use can provide an ample amount of water resources for domestic use. Installing conveyance pipes for irrigation can increase efficiency from 40 percent to over 60 percent or more than 75 percent if sprinkle or drip irrigation systems are installed (MAI 2013, 37–39). Notably, rural communities mainly depend on agriculture activities in which qat plantations have invaded the main water basins, and are mainly located at the western mountainous ranges. Local watershed management is critical to ensure best use of the water resources and to recharge groundwater aquifers. In other words, the trade-off on uses for qat and domestic consumption comes into play. Since the agriculture sector consumes more than 90 percent of the available water resources, any effective intervention to conserve water and stabilize the continual drop in the water level requires a consideration of the irrigated sector and the agriculture sector. Further opportunities might also be found through the nexus with energy, which is not only a major user of water but also has a direct impact on water sector financial sustainability and efficiency.

This diagnostic does not explore deeply the topic of WRM and only provides nominal mention of the water-agriculture-energy nexus, as the diagnostic is focused on WASH services. However, the authors recommend further and urgent research and analysis on this area. Box 6.1 provides examples of how other countries have attempted to tackle the WRM challenge, in some cases successfully.

Box 6.1: Examples of Sustainable Management of Groundwater

Worldwide, it has proved very difficult to recover control over groundwater once it has been lost. Only a handful of administrations with strong governance have had large-scale success: Australia, the European Union (EU), and one or two U.S. states. Other countries, including Jordan and India, have had local success. Successful cases have generally involved good knowledge of the resource; clear workable rules; user empowerment and self-regulation; and a partnership approach between users and government.

Australia. The government used an inclusive, evidence-based process of study and debate leading to a consensus on national water reform to return all water systems to sustainable levels of extraction and to manage groundwater sustainably. The process accompanied a long-term "decoupling" of economic growth from water use as Australia moved towards a less water-intensive economy. Total water consumption declined by 40 percent between 2001 and 2009 while the gross domestic product (GDP) grew by more than 30 percent. The measures included a wholesale institutional reform of agencies and regulatory instruments and the introduction of economic approaches to water management, including water markets to increase agricultural water productivity. Factors that helped the approach succeed:

- Strong governance and public respect for the common good
- Open democratic culture
- Adherence to an evidence-based approach
- Political commitment and wise expert guidance

The United States. In Colorado, groundwater that is confined and not connected to a wider water system is managed by a groundwater commission made up of water users. The commission allocates groundwater entitlements to the overlying landowners based on annual recharge and an agreed rate of depletion of "fossil" (nonrecharged) groundwater reserves over 100 years. On the recommendation of the commission, the Colorado Division of Water Resources issues licenses for well spacing and drilling and regulates annual extraction. Factors that helped the approach to succeed:

- Decentralization of responsibility and accountability to the users
- Good knowledge of the resource
- Cooperation between the state and users over enforcement

Jordan. Based on groundwater studies, the government assigned water rights and quotas, regulated extraction, and introduced metering within basin plans. Awareness programs strengthened understanding of the need to manage groundwater sustainably, and farmers and local communities formed associations to cooperate

box continues next page

Box 6.1: continued

in resource management. Farmers were given incentives to cooperate: their wells could be licensed to sell water for urban consumption, increasing farmer incomes and giving them incentives to pump sustainably to protect future revenues. The factors that helped the approach succeed:

- Local accountability and engagement
- Political commitment to enforcement
- Government's willingness to allow farmers to sell agricultural water to M&I

India. In Andhra Pradesh, more than half a million people are benefitting from more sustainable approaches to groundwater management. The emphasis has been on increasing the understanding of farmers of the resource within a defined groundwater basin where management decisions can make a difference (for example, changing cropping patterns to reduce water use). The actions include (a) participatory hydrological monitoring; (b) communal crop water budgeting based on available recharge; and (c) education for farmers to learn water saving techniques and cropping patterns that will keep water use within budget. The lessons from Andhra Pradesh:

- Knowledge and awareness are key to empowering farmers to manage groundwater more sustainably
- There are many ways to reduce groundwater use, some of which require investment, others simply require farmer knowledge and effort
- With careful management, farmers can both reduce groundwater use *and* earn higher incomes

Sources: Water Reform in Australia: Ken Matthews; Groundwater Governance and Management: Larry Simpson in Shaping the Future of Water for Agriculture; Sustainable Agricultural Water Management in Middle East and North Africa, FAO 2015; van Steenbergen; Options for decoupling economic growth from water use and water pollution, World Bank SBWMP ICR; and Ward 2015, 98–99.

Improve Capacity and Viability of Utilities Charged with Urban Service Provision

The major issues regarding urban water supply and sanitation services are (a) increasing the level of network access; (b) strengthening utility governance; (c) improving financial viability of service providers; (d) improving quality and efficiency of water and sanitation services; and (e) pro-poor strategies for urban water and sanitation. This section summarizes the issues and suggests future actions in the recovery period.[3] As described in a previous section on binding constraints, the problems for expanding the network include (a) the high cost;[4] the lack of adequate investment finance; the high level of subsidy and low connection fees; and, the neglect of alternative approaches such as partnerships and concessions with the private sector.[5]

Although the vast majority of the urban population is de jure covered by legally autonomous utilities that are technically decentralized, corporatized and commercialized and governed by local boards, the local corporations (LCs) are still dependent on central government for finance and for many decisions. The problems include (a) a lack of accountability of the LCs and their

boards due to the split between asset ownership and corporate governance; (b) ill-defined splits between policy and regulation and supervision and business planning; (c) continued dependence of the LCs on central government subsidy; and (d) conflict of interest, particularly between the LC boards' obligations to pursue a business approach to achieve financial autonomy and the boards' conflicting desires to keep tariffs low to benefit local populations.

Full autonomy of the LCs and accountability of the LC boards will come only when the assets are vested in the board, when central government ceases to subsidize, and when regulation is arm's length. Given the current financial problems, these are clearly longer-term objectives, although the three LCs that currently cover both O&M and electromechanical depreciation could be early candidates. As described earlier in this Diagnostic, some LCs do not recover even O&M costs, and only a handful (three out of 23) recover depreciation. No LC is creditworthy in the sense that it could afford to borrow for capital investment. The underlying problem is that tariffs for both connection and services are too low, and boards–and often the central government–are unwilling to see tariffs rise without commensurate improvement in services. The challenge is even greater because many residents are poor. Even though tariffs are low in most towns, it is public policy to cross-subsidize, which requires a more prosperous middle class and business sector. Further, there are service delivery inefficiencies, and low levels of water consumption reduce revenues below the break-even point. The post-evaluation report at the end of a World Bank-financed project (Ward et al. 2009). World Bank (2011) states: "Household surveys suggest that the number of people per connection is very high, and hence average per capita water consumption is in some towns no more than 30 liters per person per day." Under circumstances of extreme shortage, losses to the utilities increase.

A greater business approach to providing water services is required. New nationwide principles for tariff setting should be agreed, with a separate detail tariff study need to be conducted for each utility. The results–and proposed changes in tariff structures–should be part of each LC's business plan and integrated into a comprehensive approach to improving services, accompanied by dialogue and information. In the longer term, this will allow full decentralization and autonomy of the LCs. (Ward 2015, 230–31; Ward et al. 2009). There will be political challenges to setting tariffs at higher levels that need to be confronted with the arguments that (a) all consumers of public network water benefit from a massive capital subsidy when they are first connected; (b) networks and expansion of their services are the cheapest way of bringing water to consumers; (c) the current system benefits largely the better off; and (d) the alternative, such as, tankers, can cost five times as much, or more.

However, it is unlikely that any time in the near future can LCs and local governments take on the challenges on their own. Financial and technical support, along with inter-local coordination on issues such as WRM, will continue to be essential, and this will need to come from central and deconcentrated entities. Preparation for the regulator, or *jihaz*, reporting directly to Parliament was complete before the troubles, but had encountered political and agency opposition. Whether the approach will be accepted under the new dispensation is an open question (MACS 2008a, 2008b; Ward 2015, 238; Ward et al. 2009).

Strengthen Rural Services

The options for improvement identified before the conflict ensued and are still mostly feasible: (a) increasing the range of technologies offered and ensuring that agencies have incentives to offer a broader range; (b) adapting solutions to both local water resource availability and to community social and financial capacity; (c) using the "three agencies partnership" (among the GARWSP, the Social Fund for Development [SFD], and the Public Works Project [PWP]) and NGOs to ensure that the agency with the appropriate specialization addresses the needs of each community; and (d) strengthening post-investment support to ensure that technical and financial management of schemes enhances the prospects of sustainability.

The most important step is investment to strengthen agency capacity. Change should include further decentralization of GARWSP (if this proves the most effective and feasible option). All three agencies should strengthen capacity and ensure adequate and appropriate staffing for demand-responsive approach (DRA), community mobilization, and supporting WUAs.

In addition to institutional strengthening, there needs to be much stronger collaboration among the three agencies to reduce overlap and increase synergies. This would include pooling of such services as mapping, water search, monitoring and evaluation and capacity building. Partnerships among the three agencies need to ensure that schemes are adapted to local community needs. For example, GARWSP and the PWP are specialized in delivering pump-based schemes and either should be the agency of choice where groundwater pumping is the best solution. SFD specializes in spring, stream, and water harvesting schemes and should be the agency to deliver where this type of scheme is the most appropriate. Results of research and technical innovation, including the use of solar energy, should be shared among agencies. And of course, lines of responsibility and accountability need to be clear up front to avoid confusion and duplication of efforts.

NGOs need to be included in planning and programming and supported not just in delivering schemes but also in traditional NGO strengths such as community mobilization, health education, and research and development (R&D). Joint planning at the local level across basin plans is also important. Coherence, prioritization, and avoidance of duplication of capacity and programs need to be improved through alignment and coordination among agencies at the central level and especially by moves toward joint programming at the local level, with local councils and basin committees, within the framework of basin plans.

Work with the Private Sector through Development of Feasible and Agile Systems

The private sector is very active, and in many towns provides a large part of the water supply. On the whole, these private water markets seem to work efficiently, yet they charge high prices and are unregulated. As with expanding the network, the challenge is to ensure that any partnership arrangements are the subject of light-touch regulation and are efficient, equitable, and sustainable. The case study *Partnership with the local private sector in Ibb* shows what can be done (see Ward et al. 2009).

A 2010 study of private water providers in Sana'a by the Water and Environment Center at Sana's University reported positive responses, and the LCs are ready to collaborate with the private sector. Most respondents said they were interested in expanding their business within a more formal regulated framework and as partners with the LCs. Among those surveyed, these positive responses came from half of well owners; more than half of network owners; two-thirds of tanker owner-operators; and almost all water purification shop owners. All were keen to work with the LCs and with the local councils. The LCs have always expressed their willingness and several have already formed partnerships (Ibb, Sana'a) albeit it on a relatively small scale.

Each LC should prepare a strategy for public-private partnerships (PPP). The National Water Sector Strategy (NWSSIP) approach that planning for expansion should be tailored to local realities is sound: each LC should prepare a medium-term business plan showing expansion targets and how it will meet them, with particular attention to PPP approaches (Ward et al. 2009; Ward 2015, 209).

Examples of conversion of agricultural wells to urban water supply abound. The challenge is to ensure that these arrangements are the subject of light-touch regulation and are efficient, equitable, and sustainable. The case study *Partnership with the local private sector in Ibb* shows what can be done (see Ward et al. 2009). The option to work with private tankers for the transfer of bulk water from rural to urban ares – under an appropriate licensing regime – should also be explored.

The World Bank is undertaking a rapid value-chain analysis on the private water tankers in selected cities in the Republic of Yemen. The aim of the study is to understand the market better, as well as the operation mechanisms and deficits. This study should help inform the design of interventions in the sector, and provide more informed opportunities for collaboration.

Focus on WASH and Child Health and Nutrition

The Diagnostic describes the sector's links to child health; although there has been some improvement in some areas with relation to sanitation and hygiene, there is much scope for greater access. The challenges related to sanitation have been the high cost and consumers' low willingness to pay, paralleled by limited interest from government and donors.

Going forward, the Republic of Yemen must learn from lessons of the past. Enhancing nutrition sensitivity of WASH could be a real opportunity to do things differently in the reconstruction phase. Onsite sanitation, hygiene, and water quality issues need to be reconsidered in light of global experiences. A first step in the relaunch could be a city-by-city inventory and assessment of the status quo and issues, including health and environmental issues, to identify and prioritize strategic approaches that LCs and other agencies could then build into their business plans. Adoption of low-cost decentralized systems, such as small-bore sanitation (piloted by SFD in Ibb and PWP for Aden), and partnerships with the private sector, are likely to be prominent in these new approaches (Ward et al. 2009). For rural areas, it may also be useful to involve health agencies and local government structures as front-line delivery for behavior change messages. Such involvement needs to be coordinated and analyzed further. Before the conflict, GARWSP was conducting awareness campaigns on the topic, and evolving a system that involves health agencies and others (like SFD) needs to be revisited.

Greater Inclusion of the Poor and Women

In urban areas, because network water is the cheapest option, the most efficient plan would be to connect the poor, but the constraints on expanding connections make this difficult and at best a longer term solution. Solutions include (a) revising the block tariff system to become more precise in targeting the poor so that overall yield of the block tariff system is better able to meet cost recovery targets; (b) working with the private sector to expand its network coverage for the poor (for example, through output-based aid or by agreements with charities and mosques); and (c) developing innovative pro-poor strategies (for example, each LC should be required to have a pro-poor strategy in its business plan) (Ward 2015, 246–67).

In rural areas, short-term options are for agencies to review and sharpen their targeting of services to poor communities and improve the transparency of the process. In parallel, agencies should develop and offer low-cost technologies adapted to the capabilities of poor communities. Yet, the reality may be that some of the most vulnerable citizens are hard to reach, and solutions might therefore be more costly on the margin or on average. Decisions with regards to targeted subsidies need to be considered. Many traditional schemes are inadequate. They often involve unsafe water and arduous fetching over long distances, generally a corvée for women and girls. The problem is essentially that there is no systematic collaboration between public agencies and community schemes.

Evidence is that outcomes are better when women participate in WUAs, and the entry point should be conditionality about this participation. Agencies need to improve their community outreach and social mobilization capacity with female team members. A key step is to revive the focus on gender issues within all programs, learning from the Rural Water Supply and Sanitation Project (RWSSP), SFD, and NGOs. However, there is clearly considerable sociocultural and political reticence—as there is for sanitation—and change may be slow.

Donor and Partner Coordination and Collaboration

Given the immense resources and capacity requirements to support the sector going forward, more donor and partner coordination and collaboration will be essential. This means enhancing the Core Donor Group (CDG) coordination mechanism that was established to update one another on ongoing and planned activities, avoid duplication of interventions, make the best use of funds, and establish a strong coordination mechanism with government counterparts at central and basin levels. This CDG coordination platform was establish immediately after the National Water Conference held early 2011, usually holding regular monthly meetings. Later, the CDG was extended to involve the Food and Agriculture Organization (FAO); the Japan International Cooperation Agency (JICA); the International Fund for Agricultural Development (IFAD), the United Nations Children's Fund (UNICEF), – the "Extended CDG." Since the escalation of the armed conflict, the Bank has been leading this coordination and recently has re-activated the mechanism on the ground.

The incentive structure needs to be readjusted. In particular, government and donors need to shift the incentives they attach to their support toward adapting schemes and technology to the means and capabilities of communities, and toward fostering joint programming at the district and governorate level. More broadly, in the post-conflict recovery, reconstruction and development phases, donor advice, and financing will be critical. The advice and investment must be coordinated, coherent, and practical, adapted to the evolving situation.

Notes

1. These proposals need to be seen in the context of broader proposals for developing local water resources management institutions adapted to the present day context, on which see *Water Scarcity: 307–30*.
2. For a full discussion of the potential for local water management, see *Water Scarcity 331–58*. See also two papers presented in 2015 to the World Bank for a possible early pilot in local water governance in the Republic of Yemen: *Governing Local Water*; and *Easing the Republic of Yemen's Water Crisis*. See also Taher et al. 2012.
3. Much of this assessment is based on Ward et al. 2009 and Ward 2015.
4. Although the government has invested heavily in expansion projects, the rugged topography of many towns makes this high cost (average cost per new connection > USD 2,000). The NWSSIP Update concluded that the Republic of Yemen simply could not afford to meet its expansion targets – costs to meet the Millennium Development Goal (MDG) in Sana'a alone were estimated to be in excess of USD 1 billion, and nationwide costs to meet the MDGs (75 percent public network coverage) were an estimated USD 4 billion 2009–2015.
5. Although there is no clear information on performance on recent network expansion under NWSSIP, the World Bank *Urban Water Supply Project*, an eight-year $130 million program (2003–10) showed that public network expansion is possible but at high financial cost, and that network expansion does not necessarily improve service delivery. The project exceeded its target for new house connections in four cities—Sana'a, Hodeida, Ta'iz and Mukalla—financing 72,000 new connections against a planned 60,000. However, water supply actually declined during project implementation, affected by the depletion of groundwater, which was the principal water source in all four cities. Water sold per connection, which was targeted to increase by 20 percent, in fact fell by 5–10 percent in all four cities (World Bank 2011b).

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Appendix A

Matrix of Functional Assignment

Matrix of Functions and Responsible Entities

Table A.1: Republic of Yemen WASH CQ4: Institutional Analysis for Rural Water Supply and Sanitation

Theme and question	De jure situation	How actual practice conform or differs
1. Policy, Legislation and Regulation		
1.1. Who sets the legal framework for rural water supply and sanitation systems?	Cabinet Decree #21 of November 22, 2000 established national policy for rural water supply and sanitation based on principles of demand-responsiveness, decentralized community-based management, government cofinancing of capital costs and community responsibility for O&M. By its founding decree (2003), MoWE has responsibility for rural water supply and sanitation nationwide. A 2003 decree established the General Authority for Rural Water Supply Projects (GARWSP) under MoWE. Other agencies are active in RWSS, notably Social Fund for Development (SFD, reporting direct to the Prime Minister) and the Public Works Project (PWP). The Local Administration Law No. 4 (2000) provides for district council responsibility for provision of water supply and sanitation services.	Actual involvement of district councils is highly variable. There is a very large number of traditional and modern water supply schemes that are entirely private or in only occasional relations with government (e.g. for help with rehabilitation). There are also several national and international NGOs, which support aspects of rural water and sanitation. These operate in conjunction with GARWSP but are not supervised by government.
1.2. Who sets policy and technical standards for rural water supply and sanitation systems?	Basic policy and technical standards are set by Cabinet Decree #21 (2000) and by the National Water Sector Strategy (NWSSIP, 2004). The three public agencies involved (GARWSP, SFD and PWP) each set their own standards within overall policy.	

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Table A.1: continued

Theme and question	De jure situation	How actual practice conform or differs
1.3. Who is responsible for setting or providing guidance/regulation on tariffs for cost recovery?	Principles of cost recovery are set by Cabinet Decree #21 (2000), interpreted by each of the agencies.	In general, there is a public subsidy with a per household ceiling, and communities are encouraged to select the appropriate technology, contributing a share of the costs.
1.4. Who is responsible for setting water quality standards?	Ministry of Health	In practice, agencies set and monitor standards.
1.5. Who allocates and regulates raw water source?	The National Water Resources Authority (NWRA) established by Presidential Decree # 154/1996 is responsible for allocating and regulating water resources under the Water Law of 2002.	NWRA capacity to assess, allocate, license and regulate water resources is limited. In practice, agencies try to work with NWRA to source water and WUAs essentially regulate locally to the best of their ability
2. Planning and budgeting		
2.1. Who is responsible for establishing the national plan, budgets, and targets for RWSS?	MoWE is responsible for strategy (NWSSIP) and for annual planning and budgeting, in consultation with MoPD and the Ministry of Finance.	
2.2. Who is responsible for establishing sub-national plans, budget, and targets?	GARWSP, SFD, PWP are responsible for planning for their programs at district and governorate level. The Local Administration Law No. 4 (2000) provides for district council responsibility for planning for rural water supply and sanitation services.	For GARWSP, plans are established at district and governorate levels in consultation with local authorities. The plans are approved by GARWSP and by the Ministry of Local Administration at the center.
3a. Financing infrastructure - bulk and distribution		
3a.1. Who is responsible for financing the design and construction of water supply and sanitation systems?	Cabinet Decree #21 (2000) provides for central government, local government and community cofinancing of capital costs	Different agencies and donor programs work on variants on this. All require some community contribution to capital costs, usually in kind.
3b. Financing operation and maintenance/technical support)		
3b.1. Who is responsible for financing operations of water supply systems?	Cabinet Decree #21 (2000) provides for community responsibility for financing O&M through cost recovery	
3b.2. Who is responsible for financing maintenance and spare parts?		

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Table A.1: continued

Theme and question	De jure situation	How actual practice conform or differs
4. Human resources management/training/ capacity building		
4.1. Who recruits local service delivery staff?	Agencies recruit their own staff for development and capacity building: junior staff, at local level; senior staff at central level. Water user associations (WUAs) recruit their own staff for operations	
4.2. Who trains and builds capacity of local service delivery staff?	Agencies are responsible for their own staff development, with some pooling of training across agencies Agencies provide training for the WUAs under their supervision	
4.3. Who hires and fires local service delivery staff?	Agencies hire and fire their own staff – junior staff, at local level; senior staff at central level WUAs hire and fire their own staff, with ToR and training provided by the supervising agency	
4.4. Who sets wage scales for local service staff?	Agencies: parent ministry and MoCS WUAs set their own scales, under guidance	
4.5. Who pays local service delivery staff?	Agencies: the agency WUAs: community cost recovery	
4.6. Who do local service delivery staff report to?	Agencies: branches to HQ; central agencies to their parent ministry WUAs: report to the committee and AGM	
5. Governance of service provision		
5a. Asset/Infrastructure Creation		
5a.1. Who is responsible for procuring the design and construction of water supply systems?	The agencies (GARWSP, SFD, PWP) in consultation with communities	All agencies have bulk centralized procurement
5a.2. Who is the legal owner of the water supply system once it is constructed?	The WUA, after a formal handover process	

table continues next page

Table A.1: continued

Theme and question	De jure situation	How actual practice conform or differs
5a.3. Who is responsible for rehabilitating the systems?	The WUA, but with the likelihood of support from the supervising agency	
5b. Asset/Infrastructure Management (operation and maintenance)		
5b.1. Who has governance responsibility for operation and maintenance for assets (well points, piped schemes)?	The WUA	
5b.1. Who has governance responsibility for collecting fees from users?	The WUA	
5c. Coordination, monitoring, community mobilization (including participation and accountability)		
5c.1. Who is responsible for community engagement and organization to plan water supply systems?	Each agency (GARWSP, SFD, PWP) has community mobilization teams	
5c.2. Who is responsible for monitoring functionality and quality of water systems?	WUA committees with support of supervising agencies	
5c.3. Who has governance responsibility for monitoring performance of staff or provider?	WUA committees with support of supervising agencies	
6. Service delivery		
6a. Asset/Infrastructure Creation		
6a.1. Who implements the design and construction of water supply and sanitation systems?	The agency, with community contribution in kind (e.g. provision of labor for trenching)	
6a.2. Who rehabilitates the systems?	The WUA, with supervising agency support where needed	
6b. Asset/Infrastructure Management (operation and maintenance)		

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Table A.1: continued

Theme and question	De jure situation	How actual practice conform or differs
6b.1. Who has responsibility for operation and maintenance for assets	The WUA	
6b.2. Who has responsibility for collecting fees from users?	The WUA	
6c. Coordination, monitoring, community mobilization		
6c.1. Who engages and organizes communities to plan water supply systems?	The agencies, through their community mobilization teams	
6c.2. Who monitors functionality and quality of water systems?	WUAs and supervising agencies. Each agency consolidates information at governorate and national level.	For some years there was an annual review (Joint Annual Review, or JAR) at which these data were presented to a national conference for analysis, discussion and decision.
6c.3. Who is responsible for monitoring performance of staff or provider?	WUA committees monitor staff Agencies monitor the WUA Parent ministries and donors monitor the agencies	For some years, the JAR provided a common monitoring mechanism

Appendix B

Data Tabulations, Results, and Definitions (CQ1–CQ3)

Table B.1: Water Supplied by Water Trucks (%)

	2014	2005
Urban	21.4	17.5
Rural	13.3	6.9

Source: World Bank calculations using HBS 2005 and HBS 2014.

Table B.2: Access to Water from Network (%)

	Public network	
	2005	2014
Urban	69.1	69.4
Rural	9.1	14.7
Poorest 20%	9.4	22.2
2	18.1	22.4
3	25.2	26.8
4	29.9	34.7
Richest 20%	45.0	50.0

Source: World Bank calculations using HBS 2005 and HBS 2014.

Table B.3: Access to Type of Toilet 2005 (%)

	Flushed toilet	Non flushed toilet	Use other facility	No toilet
Poorest 20%	1.3	36.2	27.7	34.9
2	2.0	50.6	24.2	23.2
3	4.1	57.5	20.7	17.7
4	8.5	59.0	17.9	14.6
Richest 20%	25.8	56.8	10.5	6.9

Source: World Bank calculations using HBS 2005.

Table B.4: Access to Sewage Disposal Urban/Rural and Quintile 2005 (%)

	Public network	Covered pit	Open pit	Nothing	Other
Poorest 20%	3.5	20.7	19.6	45.6	10.3
2	7.2	31.8	18.8	32.1	9.0
3	11.4	37.5	16.3	25.9	7.6
4	16.6	39.3	13.7	21.8	6.4
Richest 20%	34.8	37.6	8.0	11.9	5.1

Source: World Bank calculations using HBS 2005.

Appendix C

Multidimensional Poverty Index (MPI)[1]

The MPI identifies multiple deprivations at the household level in education, health and standard of living. It uses micro data from Demographic and Health Survey 2013, and all the indicators needed to construct the measure must come from the same survey. More details about the general methodology can be found in Alkire and Santos (2010).

Each household is assigned a deprivation score according to the household's deprivations in each of the 10 component indicators. The maximum deprivation score is 100 percent with each dimension equally weighted; thus the maximum deprivation score in each dimension is 33.3 percent. The education and health dimensions have two indicators each, so each indicator is worth 33.3/2, or 16.7 percent. The standard of living dimension has six indicators, so each indicator is worth 33.3/6, or 5.6 percent. The two components in standard of living are related to water and sanitation measures. So wash and sanitation indicator is worth 33.3/2 or 11.2 percent.

MPI is calculated, using DHS 2013, by considering the household deprivations in Living Standards, Education, and Health.

1. A household is deprived in Living Standards if it
   i. Does not have electricity
   ii. Does not use improved drinking water sources (MDG)
   iii. Does not use improved sanitation (MDG)
   iv. Uses solid fuel for cooking and heating (non-MDG)
   v. Does not have the finished floor (non-MDG).
   vi. Assets: not having at least one asset related to access to information (phone (mobile or fixed), radio, TV) AND not having at least one asset related to mobility (bicycle, motorbike, motorboat, car, truck or animal wheel cart) OR at least one asset for livelihood (refrigerator, agricultural land or livestock -at least one cattle or at least one horse or at least two goats or at least two sheep, or at least 10 chicken)

2. Health Deprivation
   i. Child Mortality: One or more children have died in the last 5 years.
   ii. Nutrition: At least one member is malnourished

3. Education Deprivation
   i. School Attainment: No household member has completed at least six years of schooling
   ii. School Attendance: A school-age child (7–14 year: 1-year leeway in admission) is not attending school.

The index weights above three groups equally. The subcomponents are also weighted equally with in a component. Ineligible households are recoded as non-deprived households for the analysis.

Regression Analysis: WASH and Stunting

This section discusses the relationship between water and sanitation variables and malnutrition using regression techniques. Results are discussed for regression analysis where height-for-age z-scores is regressed against variables that capture water and sanitation access under various specifications.

Wealth quintiles computed by the DHS already include WASH variables in them. To be able to control for both WASH and assets, asset dummies are used instead of wealth quintiles to avoid multicollinearity. Controls for a variety of other child, mother and household specific characteristics are also included. The controls used are urban/rural dummy, dummies for governorates, asset holding, types of house, roof and floor, sex, birth order, age, age squared, and mother's education.

Appendix D and appendix E present a summary of the regression results for children below 59 and 24 months of age. The results of the regressions—across all specifications—show a strong and robust relationship between improved sanitation and height-for-age z-scores. For example, results from the first specification for children below 59 months, suggests that on average, children in households with improved sanitation are 0.5 standard deviations taller than children who grow up in households without improved sanitation. Second column includes, in addition to the household sanitation level measure, the measure for community sanitation. Again, in this specification the sanitation variables remain strongly positive and significant though the size of nutritional "return on improved sanitation" almost halves with improved sanitation taking a sizable share of the explanatory power. This attenuation of the household sanitation variable after the inclusion of community sanitation suggests that public sanitation is an important factor for child nutrition.

In the subsequent specifications other measures of WASH such as access to basic water, availability of hand wash facilities, safe disposal practices of feces and other variables are added. It is notable that all of these variables are, by and large, positively correlated with the height-for-age z-scores. Access to water appears significant in all specifications and its magnitude suggests a 0.16–0.18 standard deviations of height advantage for children in households with access to basic water. Proper disposal of feces—an important variable that captures the more behavioral side of WASH—also appears with a strong positive coefficient as expected. What is noteworthy is that throughout all of these specifications, the magnitude of the coefficients on household level improved sanitation as well as the community level sanitation remains fairly unchanged suggesting a certain degree of robustness of these results

The results for children below 24 months of age are broadly similar barring some interesting differences. First the overall magnitude of the coefficients on all variables is smaller than the corresponding magnitudes for the older kids suggesting that the effect of WASH variables on nutrition for children below 24 months of age may be more muted. This is plausible given the larger role other inputs, notably food intake, may play for the younger children. Second, unlike for the older cohort of children for whom the coefficients on community sanitation were almost twice as large as the coefficients on household level sanitation, improved sanitation at the household level appears more important for the younger children. The data do not allow us to fully explore the potential reasons for this but one hypothesis could be relative mobility of children: children above the age of two are likely to be more mobile physically and as such could face a greater exposure to potential contaminations in their immediate neighborhoods related to poor community sanitation. The availability of hand washing facility—net of all of the other WASH variables—appears not to have any statistically discernible effect on child nutrition.

Note

1. http://hdr.undp.org/sites/default/files/hdr2015_technical_notes.pdf.

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Appendix D

Height-for-Age (HAZ) on WASH Variables for Children Less than 59 Months

Improved sanitation	0.535***	0.298***	0.276***	0.243***	0.235***
	(0.0377)	(0.0398)	(0.0400)	(0.0408)	(0.0410)
Improved community sanitation		0.544***	0.500***	0.481***	0.474***
		(0.0512)	(0.0520)	(0.0528)	(0.0528)
Access to basic water			0.183***	0.161***	0.159***
			(0.0417)	(0.0421)	(0.0422)
Safe disposal of feces				0.227***	0.221***
				(0.0458)	(0.0461)
Basic hand wash facility available					0.0416
					(0.0353)
Constant	–2.064***	–2.084***	–2.151***	–2.313***	–2.320***
	(0.0291)	(0.0292)	(0.0326)	(0.0422)	(0.0431)
Observations	13,394	13,394	13,394	13,169	13,169
R-squared	0.026	0.040	0.043	0.045	0.046
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$					

Source: World Bank calculations using DHS 2013.

Appendix E

HAZ on WASH Variables for Children Less than 24 Months

Improved sanitation	0.468***	0.334***	0.316***	0.275***	0.280***
	(0.0521)	(0.0587)	(0.0588)	(0.0592)	(0.0593)
Improved community sanitation		0.311***	0.273***	0.256***	0.259***
		(0.0706)	(0.0714)	(0.0722)	(0.0724)
Access to basic water			0.158***	0.136**	0.138**
			(0.0553)	(0.0554)	(0.0555)
Safe disposal of feces				0.274***	0.277***
				(0.0701)	(0.0703)
Basic hand wash facility available					–0.0243
					(0.0513)
Constant	–1.503***	–1.515***	–1.575***	–1.780***	–1.775***
	(0.0382)	(0.0386)	(0.0444)	(0.0681)	(0.0693)
Observations	5,450	5,450	5,450	5,354	5,354
R-squared	0.018	0.022	0.024	0.026	0.026
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$					

Source: World Bank calculations using DHS 2013 data.

Appendix F and G re-runs the above specifications with more controls. Lack of significance of water and sanitation variables after addition of these controls suggest that wash variables are linked closely with other household variables.

Appendix F

HAZ on WASH Variables for Children Less than 59 Months with Additional Controls

Improved sanitation	0.0654*	0.0495	0.0486	0.0539	0.0540
	(0.0374)	(0.0381)	(0.0382)	(0.0386)	(0.0386)
Improved community sanitation		0.0921	0.0884	0.0882	0.0883
		(0.0559)	(0.0560)	(0.0563)	(0.0563)
Access to basic water			0.0559	0.0641*	0.0641*
			(0.0365)	(0.0372)	(0.0372)
Safe disposal of feces				–0.0487	–0.0486
				(0.0432)	(0.0432)
Basic hand wash facility available					–0.00212
					(0.0328)
Constant	–0.718***	–0.722***	–0.744***	–0.690***	–0.690***
	(0.197)	(0.198)	(0.199)	(0.204)	(0.204)
Additional controls	Y	Y	Y	Y	Y
Observations	13,292	13,292	13,292	13,067	13,067
R-squared	0.202	0.203	0.203	0.205	0.205
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$					

Source: World Bank calculations using DHS 2013 data from the Republic of Yemen.
Note: Additional controls include urban/rural dummy, dummies for governorates, dummies for asset holding, types of house, roof, and floor, sex of the child, birth order and mother's education. With addition of more controls the coefficients on wash variables are not significant anymore except for access to basic water suggesting that wash variables are correlated with other household/child/mother characteristics.

Appendix G

HAZ on WASH Variables for Children Less than 24 Months with Additional Controls

Improved sanitation	0.0875	0.0938	0.0932	0.0807	0.0870
	(0.0570)	(0.0589)	(0.0591)	(0.0598)	(0.0598)
Improved community sanitation		–0.0357	–0.0399	–0.0313	–0.0318
		(0.0811)	(0.0813)	(0.0814)	(0.0814)
Access to basic water			0.0602	0.0665	0.0670
			(0.0536)	(0.0538)	(0.0539)
Safe disposal of feces				–0.0427	–0.0408
				(0.0660)	(0.0660)
Basic hand wash facility available					–0.0915*
					(0.0498)
Constant	–0.605**	–0.604**	–0.629**	–0.529*	–0.530*
	(0.306)	(0.306)	(0.307)	(0.314)	(0.313)
Additional controls	Y	Y	Y	Y	Y
Observations	5,410	5,410	5,410	5,314	5,314
R-squared	0.155	0.155	0.155	0.157	0.157
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$					

Source: World Bank calculations using DHS 2013 data from the Republic of Yemen.
Note: Additional controls include urban/rural dummy, dummies for governorates, dummies for asset holding, types of house, roof, and floor, sex of the child, birth order and mother's education. Adding more controls, the coefficients on wash variables are not significant anymore except for access to basic hand wash facility where the marginal effect is in the direction where it would not have ex-ante expected. This suggests that wash variables are correlated with other household/child/mother characteristics.

Appendix H

Adequacies and Components

Adequacies	Components	Definition			
		1	2	3	4
Food	Dietary diversity	Y	Y	Y	Y
	Minimum meal frequency	Y			
	Minimum acceptable diet	Y	Y	Y	Y
Health	At least four prenatal checkups	Y	Y	Y	Y
	Birth assisted by skilled professional	Y	Y	Y	Y
	Birth in a hospital/clinic	Y	Y	Y	Y
	Postnatal check within 2 months	Y			
	Age specific vaccination completed	Y			
Care	Mother literacy	Y	Y	Y	Y
	Mother exposure to media	Y	Y	Y	Either/or
	Mother empowerment	Y	Y	Y	
	Mother money decision	Y			
	Exclusive breastfeeding	Y	Y	Y	Y
	Breastfed Immediately	Y			
Environment	Basic water	Y	Y	Y	Y
	Improved sanitation	Y	Y	Y	Y
	Improved sanitation community	Y	Y	Y	
	Safe disposal of feces	Y	Y		
	Has hand wash facility	Y			

Diet Diversity: Has at least four out of seven food groups consumed in last 24 hours for children between 6 and 23 months and continuously breast fed for children below 6 months of age.

1. grains, roots and tubers
2. legumes and nuts
3. dairy products (milk, yogurt, cheese)
4. flesh foods (meat, fish, poultry and liver/organ meats)
5. eggs
6. vitamin A rich fruits and vegetables
7. other fruits and vegetables

Meal Frequency: Reflects the frequency of feedings of children in a household.[1]

1. Breast fed if less than 6 months.
2. At least 2 times for breastfed infants 6–8 months
3. At least 3 times for breastfed children 9–23 months
4. At least 4 times for non-breastfed children 6–23 months

Minimum Acceptable Diet: Breast fed if children less than 6 months. For children 6–23 months the minimum acceptable diet consists of diet diversity of 4 or greater, currently breastfed or receiving milk feedings and age appropriate minimum meal frequency.

Age Specific Vaccination:

Vaccine schedule:

1. BCG: at birth
2. DPT/Tetra/penta: 2, 3, 4 months
3. Measles: 9 months
4. Oral polio: birth, 2, 3, 4 months

Fully vaccinated: 1 BCG, at-least 3 Polio, 3 DPT, and 1 Measles. Uses mother recollections and date/mark on the vaccination card. Source: Republic of Yemen DHS report page 107.

Mother Exposure to Media: At least once per week reads newspaper, listens to radio or watches TV daily.

Mother Empowerment: Mother is empowered to make own health decisions (jointly or alone).

Mother Money Decision: Mother makes decisions regarding large purchases (alone or jointly).

Improved Water (DHS): Water from public/private network, tube well or borehole, water bottle, and rain water.

Basic Water (DHS): If the household receives improved water and it takes less than 30 mins for trip if collected outside the household.

Improved Sanitation (DHS): Household has non-shared flush toilet. Since pit latrine is ambiguous only access to flush toilet is used to define improved sanitation.

Improved Community Sanitation: If more than 75 percent of the household in the cluster have improved sanitation.

Basic Hand Wash: Has hand washing facility with water and soap.

The stunting and adequacies are for the first three definitions are given below. The results show fewer children satisfy multiple adequacies and more adequacies is linked to lower level of stunting.

Note

1. who definition

Appendix I

Percent with Adequacies and Stunting

	Definitions					
	1		2		3	
	Adequacy	Stunting	Adequacy	Stunting	Adequacy	Stunting
Food only	11.3	25.5	9.0	28.1	9.0	28.1
Care only	3.0	41.4	5.6	39.8	5.6	39.8
Health only	0.8	28.7	3.8	37.8	3.7	38.2
Environment only	6.7	27.6	7.6	33.6	7.7	33.5
Food and health only	0.1	15.8	1.0	21.9	1.0	21.9
Food and care only	1.0	21.6	2.0	24.4	1.9	24.7
Food and environment only	1.1	21.6	1.0	29.1	1.0	28.9
Health and care only	0.0	16.7	0.6	30.4	0.6	30.4
Health and environment only	0.7	23.4	2.3	23.0	2.3	22.5
Care and environment only	0.5	30.9	1.6	26.6	1.6	27.0
Food, health, and care only	0.0	25.0	0.5	14.5	0.5	14.8
Food, health, and env only	0.2	3.7	0.5	14.3	0.5	14.3
Food, care, and env only	0.3	27.3	0.5	16.9	0.5	16.2
Health, care, and env only	0.0	16.7	0.4	26.8	0.4	26.8
All	0.1	10.0	0.6	10.5	0.6	10.4
None	74.2	53.0	63.2	55.7	63.1	55.7

Source: World Bank calculations using DHS 2013 data from the Republic of Yemen.

Appendix J

Synergies Regression Framework

In this section, an effort is made to derive some quantitative estimates of the role of synergies associated with having simultaneous access to adequate levels in one or more of the clusters of food security, child care, and health and environment, on child nutrition (Skoufias 2016). The analysis is purely descriptive, in that it is aimed at quantifying the correlation between improved or higher height for age Z-scores and simultaneous access to adequate levels in more than one of the clusters. To explore the potential synergies among the clusters of underlying determinants and nutritional outcomes, a simple regression model is used to summarize in a parsimonious way the differences in the mean height-for-age among children with access to only or more of the three of the three clusters of the underlying determinants of nutrition. Purposefully, no additional controls are used in these regressions since including such controls is likely to create the impression that an effort is made to minimize the influence of confounding factors in the relationship between the dependent and independent variables in the regression, a practice common to all studies aimed at estimating causal regressions within an econometric framework.

Model

The following econometric specification is used:

$$haz_i = \alpha + \sum_{\{i=1\}}^{\{4\}} \beta_i A_i + \sum_{\{i,j=1\}}^{\{4\}} \gamma_{ij} A_i A_j + \sum_{\{i,j,k=1\}}^{\{4\}} \gamma_{ijk} A_i A_j A_k + \gamma_{1234} A_1 A_2 A_3 A_4 + \varepsilon_i$$

where HAZ_i is the Height-for-Age Z-scores for the child *i,* and *A*'s denote access to the adequacies, for each child *i*. The adequacies are binary variables. The synergy are the interaction terms in the above analysis. These binary variables are constructed without any consideration of whether the child has access to adequate levels in the other two 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 of children defined by the extent to which they have access to one or more of the pillars.

In the above specification the constant term provides an estimate of the mean value of HAZ scores for children without access to adequate food security, adequate environment, adequate health, and adequate care. The coefficients β_i yield estimates of the increase in the mean HAZ score of children when a child has access to adequate levels in one of the clusters only (and not the others). Moreover, the coefficients γ_{ij} and γ_{ijk} 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. The coefficient γ_{1234} summarizes the potential synergies from simultaneous access to all three components.

The model employed above 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 clusters

themselves are to a large extent choice variable (e.g., such as child care variables, vaccinations, and visits for prenatal care) 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 such a 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 the other clusters. 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 child based on information in one-time period.

Reference

Skoufias, E. 2016. "Synergies in Child Nutrition: Interactions of Food Security, Health and Environment, and Child Care." World Bank Policy Research Working Paper No. 7794. World Bank, Washington DC.

Appendix K

Regression of Height for Age z-Scores on Adequacies[1]

This section analyzes nutritional outcomes through the lens of this UNICEF conceptual framework using methodology developed by Skoufias (2016). This methodology entails the estimation of a single equation that links adequacies to basic services with nutritional status of children. The first key step in implementing this methodology is the determination of the adequacy status of each child along each of the dimensions. Once the adequacy status is determined, the regression methodology requires the inclusion of combination of interactions of various adequacies in the regression with height-for-age z-score as the primary dependent variable. The purpose of the econometric specification is to find the correlations in adequacies that affect child nutrition. This model does not allow for causal inference of adequacies on child health and that is not even the objective of the analysis. The objective is simply to assess correlations, particularly of the interaction variables.

Appendix L reports the effects of adequate food, health, care, and environment and their interactions on height for age z-scores for children aged 0–23 months. Environment includes water and sanitation variables. The individual and interactions effects are reported separately. With regression framework is calculating correlation of each of the adequacies along with interactions with the measure of child nutrition. Additional variables that affect height for age like mothers (age, education, etc.) and households (household head employment, urban/rural etc.) characteristics which affects child health outcomes are not controlled for. Also this model does not allow for casual inference on the effects of the various adequacy components on nutrition. In addition to this care has to be taken in interpreting results that use stricter definitions since the observations satisfying each adequacies are likely to be fewer which might compromise the quality and precision of the estimates. Once the marginal effects are calculated, total effects are calculated by summing up the necessary coefficients and shown in appendix M.

The results in column one of appendix L are given for the most restrictive of definitions. The coefficient on individual terms are positive and significant except of care only. Care may not have positive effects since higher care may be given to unhealthy children. The coefficients on food only is .605. This can be interpreted as the unconditional correlation between the household being adequate in food and children HAZ-scores outcome. In addition to positive effects there are negative effects. The coefficient on food and environment is –0.396. Negative marginal coefficients do not imply that children who are adequate in some combination of adequacies have lower height for age z-scores but the individual adequacies are overestimated. This can be seen by looking at total effects in appendix M where all the coefficients are positive. The total effect of food and environment is 0.74 suggesting that there is significant synergy in food and environment.

In the subsequent columns regression results with less restrictive definitions of adequacies are given. For definition two: drop minimum diversity for food adequacy, drop postnatal check within 2 months and age specific vaccination completed for adequate health, drop mothers' decision on spending money and breastfed immediately for adequate care, and drop hand wash facility for adequate environment. Dropping safe disposal of feces from adequate care of definition two to construct definition three with other adequacies same

as in definition two. The marginal coefficients on four adequacies (first four rows) are always positive and significant including care. The only significant difference in results from definition one is the that the coefficient on "Care Only" is positive now. Also since the definitions of adequacies did not change by a lot the coefficients on column two and three are very similar. Column four includes definitions which are the most relaxed. Adequate food and health are unchanged as in definitions two and three. Define adequate care by requiring either/or for mother exposure to media and mother empowerment rather than both conditions to be satisfied. Dropping community sanitation while defining adequate environment. After these adjustments the estimation result is given in column four. As with previous results there are significant synergies shown by first four rows of appendix L and appendix M. More of the variables are statistically significant as the condition are relaxed suggesting that the estimation is becoming more precise with the disclaimer that this is an exercise in correlation and not causal.

In conclusion, adequate access to food, health, care, and environment matters in achieving improved outcome for child nutrition. Environment in particular water and sanitation has a positive and statistically link with improved child nutrition. In terms of policy, satisfying all the different adequacies the returns are higher than trying to solve single dimension of adequacies. The final caveat is that this is a purely correlational study and not a casual study.

Note

1. The regression model and coefficients are discussed in appendix J.

Reference

Skoufias, E. 2016. "Synergies in Child Nutrition: Interactions of Food Security, Health and Environment, and Child Care." World Bank Policy Research Working Paper No. 7794. World Bank, Washington DC.

Appendix L

Marginal Effects (Synergies) in Mean HAZ of Children Less than 24 Months

	Definitions			
Adequacies	1	2	3	4
Food only	0.605***	0.600***	0.600***	0.619***
Care only	0.172	0.400***	0.404***	0.405***
Health only	0.541**	0.499***	0.499***	0.532***
Environment only	0.577***	0.531***	0.522***	0.500***
Food and health	0.140	–0.242	–0.242	–0.458**
Food and care	0.0991	–0.145	–0.155	–0.120
Food and environment	–0.396**	–0.546***	–0.539***	–0.385***
Health and care	0.0179	–0.209	–0.213	–0.406
Health and environment	–0.383	–0.200	–0.191	–0.213
Care and environment	0.0509	–0.350	–0.369	–0.446**
Food, health, and care	–0.395	0.318	0.311	0.701
Food, health, and environment	0.125	0.572	0.564	0.693**
Food, care, and environment	–0.425	0.497	0.535	0.310
Health, care, and environment	–0.201	0.599	0.618	0.859**
Food, health, care, and environment	0.485	–0.991	–1.001	–1.197**
Constant	–1.583***	–1.684***	–1.683***	–1.729***
Observations	5,450	5,446	5,446	5,446
R-squared	0.036	0.047	0.047	0.050
Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$				

Source: World Bank calculations using DHS 2013 data.

Appendix M

Total Effects on HAZ

	Definitions			
Adequacies	1	2	3	4
Food and health	1.29	0.86	0.86	0.69
Food and care	0.88	0.86	0.85	0.90
Food and environment	0.79	0.59	0.58	0.73
Health and care	0.73	0.69	0.69	0.53
Health and environment	0.74	0.83	0.83	0.82
Care and environment	0.80	0.58	0.56	0.46
Food, health, and care	1.18	1.22	1.20	1.27
Food, health, and environment	1.21	1.21	1.21	1.29
Food, care, and environment	0.68	0.99	1.00	0.88
Health, care, and environment	0.77	1.27	1.27	1.23
All	1.33	1.48	1.49	1.12

Source: World Bank calculations using DHS 2013 data.

Appendix N and O re-runs the above regression results with additional controls. The results below show that adequacy variables are correlated with these additional controls.

Appendix N

Marginal Effects (Synergies) in Mean HAZ of Children Less than 24 Months with Controls

	Definitions			
Adequacies	1	2	3	4
Food only	0.0871	0.165**	0.164**	0.174**
Care only	–0.103	0.152	0.155	0.183*
Health only	0.250	0.108	0.109	0.190
Environment only	0.114	0.0868	0.0868	0.185**
Food and health	0.329	–0.0254	–0.0244	–0.285
Food and care	0.160	–0.178	–0.187	–0.164
Food and environment	–0.336*	–0.393**	–0.382**	–0.238*
Health and care	0.170	–0.259	–0.261	–0.478*
Health and environment	–0.169	0.0817	0.0847	–0.138
Care and environment	0.204	–0.255	–0.262	–0.369**
Food, health, and care	–0.708	0.299	0.297	0.717*
Food, health, and environment	0.120	0.461	0.450	0.720**
Food, care, and environment	–0.148	0.354	0.398	0.186
Health, care, and environment	–0.170	0.701	0.709*	0.998**
Food, health, care, and environment	0.248	–1.038*	–1.062*	–1.307**
Constant	–0.649**	–0.700**	–0.701**	–0.708**
Additional controls	Y	Y	Y	Y
Observations	5,410	5,406	5,406	5,406
R-squared	0.156	0.158	0.158	0.159
Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$				

Source: World Bank calculations using DHS 2013 data from the Republic of Yemen.
Note: Additional controls include urban/rural dummy, dummies for governorates, dummies for asset holding, types of house, roof, and floor, sex of the child, birth order and mother's education.

Appendix O

Total Effects on HAZ for Children Less than 24 Months with Additional Controls

	Definitions			
Adequacies	1	2	3	4
Food and health	0.67	0.25	0.25	0.08
Food and care	0.14	0.14	0.13	0.19
Food and environment	–0.15	–0.14	–0.13	0.12
Health and care	0.32	0.00	0.00	–0.11
Health and environment	0.20	0.28	0.28	0.24
Care and environment	0.22	–0.02	–0.02	–0.00
Food, health, and care	0.19	0.26	0.25	0.34
Food, health, and environment	0.40	0.48	0.49	0.61
Food, care, and environment	–0.02	–0.07	–0.03	–0.04
Health, care, and environment	0.30	0.62	0.62	0.57
All	0.05	0.26	0.28	0.37
Additional controls	Y	Y	Y	Y

Source: World Bank calculations using DHS 2013 data from the Republic of Yemen.

Appendix P

Access to Water and Sanitation Tiers

TIER 4 – On premise piped and safe water
Satisfies JMP "piped water", on premises, and has no E.coli at source

TIER 3 – Safely managed water
Satisfies JMP "Improved," on premise, and has no E.coli at source

TIER 2 – SDG basic water
Satisfies JMP "Improved" technology and w/in 30 min roundtrip collection *(improved and proximal)*

TIER 1 – MDG improved water
Piped water to yard/plot, public taps or standpipes, tubewells or boreholes, protected springs, rainwater

TIER 0 – Unimproved water
Unprotected springs, unprotected dug wells, cart with small tank/drum, tanker-trunk, surface water, bottled water

TIER 3 – Improved sanitation and handwashing
Unshared, satisfies JMP "improved" technology, and has handwashing facility with available cleansing agent and water

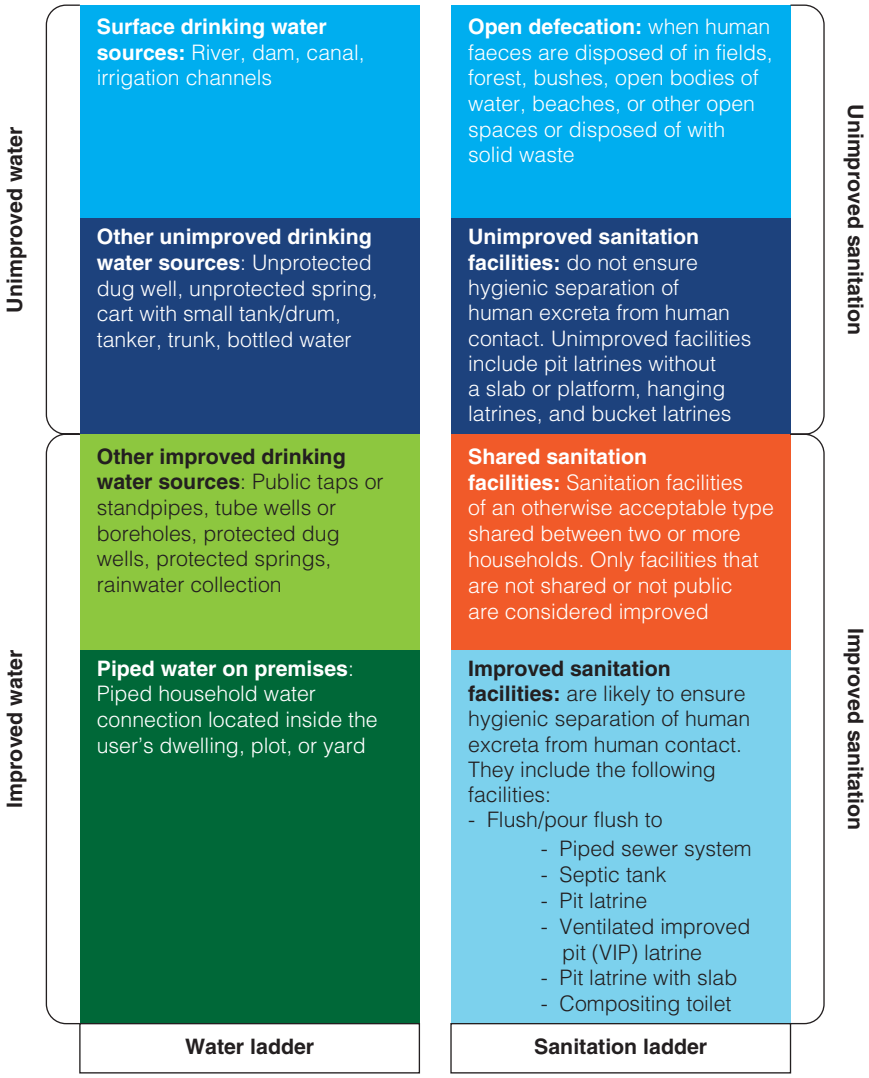
TIER 2 – Improved sanitation (excluding shared)
Unshared "improved" facilities

TIER 1 – Improved sanitation (including shared)
Unshared "improved" facilities including flush toilet to piped sewer system, septic tank, or pit latrine; ventilated improved pit latrine (VIP), pit latrine with slab, composting toilet

TIER 0 – Unimproved sanitation
No facilities/bush or field or use of bucket, hanging toilet/hanging latrine, pit latrine without slab, flush/pour to elsewhere

Appendix Q

Water and Sanitation Ladders (JMP)[1]



Note

1. http://www.wssinfo.org/definitions-methods/watsan-ladder/.

Appendix R

Water and Sanitation Ladders (JMP Post-2015)